PROG. DEV. OFFICE

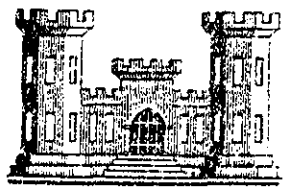
WATER RESOURCES DEVELOPMENT PROJECT

NORTH NASHUA RIVER BASIN

WHITMANVILLE LAKE

WHITMAN RIVER, MASSACHUSETTS

DESIGN MEMORANDUM NO. 2



GENERAL DESIGN

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

AUGUST 1971

19

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO:

NEDED-E

31 August 1971

SUBJECT: Whitmanville Lake, Whitman River, North Nashua River Basin, Massachusetts, Design Memorandum No. 2, General Design

Chief of Engineers
ATTN: ENGCW-E

1. In accordance with ER 1110-2-1150, there is submitted for review and approval Design Memorandum No. 2, General Design, for the Whitmanville Lake Project.

2. This report conforms to modifications made as a result of reformulation of the project's purposes. A description of the departures from the authorized plan and the reason for the changes are outlined in the text of the report and in Appendix A. A detailed report on the results of the reformulation of the project has been sent to other agencies for review and comment. Additional comments received will be forwarded for insertion in Appendix C.

3. In accordance with Paragraph No. 2 of Reference ENGCW-EZ: Letter of Approval of Report: "Justification For Altering Project Purposes", dated 28 May 1971, the drafts of letters to the Office of Management and Budget and to Congressional Committees were forwarded to OCE on 29 July 1971.

4. A draft of the recreational development contract, as required by ER 1180-1-1, Change 5, Appendix A, between the Federal Government and the Commonwealth of Massachusetts and a letter indicating concurrence by the Commonwealth is being prepared and will be submitted to OCE upon completion.

5. It is recommended that the project plan providing multiple-use storage for flood control, water quality control and recreation be approved as a basis for the preparation of detailed Design Memoranda and contract plans and specifications.

FOR THE DIVISION ENGINEER:

John Wm. Leslie

Incl (14 cys)
as

JOHN Wm. LESLIE
Chief, Engineering Division

WATER RESOURCES DEVELOPMENT PROJECT
North Nashua River Basin - Merrimack River
Massachusetts

Whitmanville Lake

Whitman River

Design Memoranda Index

No.	Title	Scheduled Submission	Date Submitted	Date Approved
1	Hydrology	May 1970	7 May 70	10 Jul 70
1	Hydrology (Revised)	July 1971	15 Jul 71	
2	General Design	July 1971	31 Aug 71	
3	Public Use - Land Use Requirement Plan	Sept 1971		
4	Relocations	Sept 1971		
5	Real Estate	Nov 1971		
6	Concrete Materials	Nov 1970	26 Feb 71	29 Mar 71
7	Site Geology	Dec 1970	31 Mar 71	29 Apr 71
8	Embankments and Foundations	Sept 1971		
9	Hydraulic Analysis	Sept 1971		
10	Detailed Design of Structures	June 1972		

WATER RESOURCES DEVELOPMENT PROJECT

NORTH NASHUA RIVER BASIN

WHITMANVILLE LAKE

MASSACHUSETTS

DESIGN MEMORANDUM NO. 2

GENERAL DESIGN

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WATER RESOURCES DEVELOPMENT PROJECT

NORTH NASHUA RIVER BASIN

WHITMANVILLE LAKE
WHITMAN RIVER
MASSACHUSETTS

A. PERTINENT DATA

1. Purpose	Flood Control, Water Quality Control, Recreation, Water Supply (replacement of existing water system)
2. Location of Dam	
State	Massachusetts
County	Worcester
Towns	Westminster & Ashburnham
River	Whitman River
Distance from:	
Confluence Whitman River and North Nashua River	4 miles upstream
Confluence North Nashua and Nashua Rivers	18 miles upstream
Fitchburg, Mass.	5 air miles, northwest
Worcester, Mass.	25 air miles, north
Boston, Mass.	40 air miles, northwest
3. Drainage Areas	
Whitman River at damsite	17.5 square miles
Whitman River at mouth, confluence with North Nashua River	27.5 square miles
North Nashua at mouth, confluence with Nashua River	132 square miles

3. Drainage Areas (Cont'd)

Nashua River at Mouth confluence with Merrimack River	530 square miles
Merrimack River at mouth	5000 square miles

4. Stream Flow

Record of USGS Gaging Station on North Nashua River near Leominster, (Drainage Area = 107 square miles) September 1935 to September 1967.

Time	c.f.s.	c.f.s./square mile
Average Annual (32 years)	188.3	1.76
Maximum Year* (1956)	307.	2.87
Minimum Year* (1965)	81.2	0.76
Maximum Month (Mar. 1936)	1,289.	12.05
Minimum Month (Aug. 1941)	38.1	0.36
Maximum Day (18 Mar.1936)	7,530.	70.37
Minimum Day (27 Sept. 1936)	22.	0.21
Instantaneous Max. (18 Mar. 1936)	16,300.	152.

* Water Year, Oct. 1 through Sept. 30

5. Maximum Floods of Record

Record of USGS Gaging Station on North Nashua River near Leominster, Massachusetts.

	Peak Discharge	
Time	c.f.s.	c.f.s./square mile
18 March 1936	16,300	152
21 Sept. 1938	10,300	96
15 Oct. 1955	8,870	83
25 June 1944	8,100	76
12 March 1936	5,500	51

6. Criteria for Spillway Design Flood

Peak inflow, c.f.s.	25,000
Total volume of rainfall, inches	21.4
Infiltration rate, inches per 3-hour period	0.20
Total volume of runoff, acre-feet	18,500
Total volume of runoff, inches	19.8
Duration of storm, hours	24
Reservoir stage at start of flood, ft., m.s.l.:	
For spillway design	845.0
For freeboard design	834.8
Gates	Closed

7. Reservoir Elevations, Areas and Capacities

Location	Elevations Ft., msl.	Area Acres	Acre Feet	Inches on Drainage Area
* Water Supply Pool (Top)	817.5	110	1,150	1.2
Flood Control Storage	817.5-845.0	382	6,700	7.2
Spillway Crest	845.0	382	7,850	8.4
Maximum Surcharge	856.3			
* * Recreation Pool	817.5-826.6	196	1,400	1.5

* Replacement of Existing Water Supply

* * Seasonal encroachment on flood control storage; 800 a.f. of 1,400 a.f. to be used for W.Q. in months of September and October.

8. Dam and Appurtenant Structures

a. Dam

Type	Rolled earth fill with rock protection
Top elevation	860.5
Top Width, Feet	20
Maximum Base Width, Feet	660
Maximum Height, Feet	76
Length, Feet	1,430
Slope, upstream above berm	1 on 4

8. Dam and Appurtenant Structures (Cont'd)

a. Dam

Type	Rolled earth fill with rock protection
Berm at Elevation	830.5
Slope, upstream below berm	1 on 4
Slope, downstream to berm	1 on 2.5
Berm @ Elevation (between Sta 9/00 and 13/00)	810.0
Freeboard, feet:	
above spillway design surcharge	4.2
above freeboard design surcharge	5.0

b. Spillway

Type	Uncontrolled concrete weir, chute channel in rock
Crest Length, Feet	150
Crest Elevation, Feet, msl	845.0
Maximum surcharge, Feet	11.3
Spillway design discharge, cfs	19,300

c. Outlet Works

(1) Flood Control

Type	Upstream intake tower; dry-well type and reinforced concrete rectangular shaped cut-and-cover conduit
Size of Conduit	4' x 5'
Length of conduit, portal to portal, feet	423.25
Conduit invert elevation, feet, m.s.l.	790.0
Number of Gates	Two
Size of Gates	3' x 4'

c. Outlet Works (Cont'd)

Type of Gates	hydraulic operated vertical slide gates
Elevation gate sill, feet, m.s.l.	790.0

Discharge capacity of outlet, reservoir at spillway crest, = 725 c.f.s.

(2) Water Quality Control

Type	Dual level inlets with a common header discharging into the flood control conduit.
Inlets	
Size of inlets	24-inch dia.
Number of valves	Two
Size of valves	24-inch dia.
Type of valves	Butterfly
Control Header	
Size of header	36-inch dia. reducing to 20-inch dia.
Number of valves	One
Size of valve	20-inch
Type of valve	Butterfly

9. Real Estate

a. Fee Acquisition

(1) Land

Classification	Area, Acres
Industrial	3
Residential	27
Developable	51
School Land	15

9. Real Estate (Cont'd)

a. Fee Acquisition

(1) Land

Classification	Area, Acres
Woodland and Cleared	408
Roads	17
River	117
Total Land	638

(2) Improvements

Classification	Units
Residences	27
Industrial	1
Total Improvements	28

10. Relocations

a. Roads	Existing Mileage	Proposed Mileage
Highways	3.5	3.0
b. Utilities		
Electric Distribution Lines	2.3	2.0
Telephone Exchange Lines	2.5	2.0
Water Supply Line (Raised)	0.2	0.2

11. Principal Quantities

Common Excavation, General	260,000 c.y.
Common Excavation, Borrow	460,000 c.y.
Rock Excavation, Open Cut	49,000 c.y.
Rolled Earth Embankment	585,000 c.y.
Gravel Bedding, Gravel Fill and Sand Fill	99,000 c.y.

11. Principal Quantities (Cont'd)

Rockfill and Rock Slope Protection	44,000 c.y.
Concrete	4,300 c.y.
Cement	6,400 bbl.
Steel Reinforcement	200,000 lbs.

12. Estimated Project Cost (1971 Price Level)

Lands and Damages	1,400,000
Relocations	1,130,000
Reservoir	200,000
Dam and Appurtenant Structures	3,400,000
Access Road	35,000
Buildings, Grounds and Utilities	110,000
Permanent Operating Equipment	60,000
Recreation Facilities	260,000
Engineering and Design	685,000
Supervision and Administration	470,000
TOTAL ESTIMATED PROJECT COST	7,750,000

585
93
44
728 cy

WATER RESOURCES DEVELOPMENT PROJECT

NORTH NASHUA RIVER BASIN

WHITMANVILLE LAKE
WHITMAN RIVER, MASSACHUSETTS

DESIGN MEMORANDUM NO. 2
GENERAL DESIGN
AUGUST 1971

B. INTRODUCTION

1. Purpose. - This memorandum furnishes information and presents the general plan for the Whitmanville Lake Project. It is also intended to serve as a basis for further planning and for detailed design.

2. Scope. - This memorandum presents general data for the entire project, including costs and benefits. The data contained herein will be supplemented and expanded, as required by subsequent design memoranda.

C. PROJECT AUTHORIZATION

3. Authorization. - The Whitmanville Lake Project was authorized by the Flood Control Act approved 7 November 1966, Public Law 89-789 which reads in part as follows:

> "The project for North Nashua River, Massachusetts, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 113, Eighty-ninth Congress, at an estimated cost of $15,816,000."

Whitmanville Lake, as authorized as part of the North Nashua River Plan, contained the project purposes of flood control and industrial water supply.

4. Reformulation. - Lack of interest in the industrial water supply aspect and the obligation to include water quality control required reformulation of the North Nashua River Plan. As a result of reformulation, the purposes for Whitmanville Lake were changed to include recreation and water quality control in addition to flood control. The justification for changing the project purposes (which affected Whitmanville Lake and Nookagee Lake) was submitted as a report on 12 February 1971 and was approved as a basis for further planning on 28 May 1971. The justification report and letter of approval are contained in this Memorandum as Appendix A.

5. Chief of Engineers Recommendations. - In Senate Document No. 113, 89th Congress, 2nd Session, the Chief of Engineers ".....concur in the views and recommendations of the Board", for which the Board of Engineers for Rivers and Harbors recommended:

" a. That the general plan for development of the North Nashua River Basin, as presented by the Division Engineer, be approved as a guide for immediate and future water resources conservation;

b. That four of the reservoirs namely, Whitmanville, Nookagee, Phillips, and Monoosnoc, and the three local-protection projects be authorized for construction in the interest of flood control, water supply, recreation, and other purposes generally in accordance with the plan of the Division Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated first cost of $16,090,000, of which $15,503,500 would be Federal and $586,500 would be non-Federal, and at an estimated average annual cost for maintenance and operation of $59,600, of which $20,200 would be Federal and $39,400 non-Federal, prior to reimbursement for water supply, and that any element of the plan may be undertaken independently of the others whenever funds for that purpose are available and the prescribed local cooperation has been furnished;

c. That immediately following authorization of the four reservoir projects, detailed site investigation and design be made for the purpose of accurately defining the project lands required; that subsequently advance acquisition be made of such title to such lands as may be required to preserve the sites against incompatible developments; and that the Chief of Engineers be authorized to participate in the construction or reconstruction of transportation and utility facilities in advance of project construction, as required to preserve such areas from encroachment and avoid increased costs for relocations;

d. That prior to construction of the Whitmanville, Nookagee, Phillips, and Monoosnoc reservoir projects, responsible non-Federal interests give assurances satisfactory to the Secretary of the Army that they will:

(1) Repay all the costs allocated to water supply, as determined by the Chief of Engineers, in accordance with the provisions of the Water Supply Act of 1958, as amended, presently estimated as follows:

Reservoirs	Apportioned initial construction cost for water supply		Annual operation, maintenance and major replacements	
	Percent	Amount	Percent	Amount
Whitmanville	29.4	$1,130,000	38.3	$2,300
Nookagee	36.5	$1,980,000	11.0	$2,200
Monoosnoc	27.6	$ 720,000	9.5	$1,600

(2) . . .

(3) Protect channels downstream of the reservoirs from encroachments which would adversely affect operation of the system;

(4) Hold and save the United States free from all damages due to water-rights claims resulting from construction and operation of the reservoirs; and

(5) Exercise to the full extent of their legal capability, control against removal of water in the basin which will affect the reservoirs' water supply storage and the development of dependable stream regulations." (Note: These requirements have subsequently been modified due to project reformulation - See Paragraph 51 - Project Reformulation).

D. INVESTIGATIONS

6. Latest Interim Report. - The interim report on review of survey for flood control and allied purposes, Merrimack River Basin, North Nashua River, Massachusetts, dated 25 January 1965 contains the report on Whitmanville Lake. The report was published without appendicies, except letters of comments, in Senate Document No. 113, 89th Congress, 2nd Session. The preparation of the report was authorized by resolution of the Senate Committee on Public Works on 9 February 1961. The report recommended that the water resources plan for the North Nashua River Basin be authorized to provide seven reservoirs and three local protection projects. Further, the report recommended that four of the reservoirs designated as Whitmanville, Nookagee, Phillips and Monoosnoc, and the three local protection projects be authorized for immediate construction for the purposes of flood control, water supply, recreation, and fish and wildlife conservation as applicable. The report provided for construction of a dual purpose project on Whitman River to include 6,700 acre-feet for flood control and 2,650 acre-feet for industrial water supply with the total capacity equivalent to 10.0 inches of runoff from its net drainage area of 17.5 square miles. The site is in the Towns of Westminster and Ashburnham and is about 4 miles upstream from the confluence of Whitman River and the North Nashua River.

7. Prior Reports. - Flood control in the North Nashua River and its tributaries has been considered in the following published reports on the Merrimack River Basin.

a. "308" Report. - The Merrimack River in New Hampshire and Massachusetts was studied by the Corps of Engineers under provisions of House Document No. 308, 69th Congress, 1st Session, which was enacted into law with modifications in Section 1 of the

River and Harbor Act of 21 January 1927. The reports prepared became known as the "308" Reports. The Merrimack River report was published as House Document No. 649, 71st Congress, 3rd Session.

b. 1938 Survey Report for Flood Control. - Following the disastrous flood of March 1936, a report for the Merrimack River Basin was submitted and published as House Document 689, 75th Congress. The report recommended modification of the existing project, adopted in the Flood Control Act of 1936, and to provide for the construction of a system of flood control reservoirs and related flood control works which may be found necessary by the Chief of Engineers. This system was authorized by the 1938 Flood Control Act and included four reservoirs and local protection projects at five locations being:

Project	
Dams and Reservoirs	Present Status
Blackwater	Completed
Edward MacDowell	Completed
Franklin Falls	Completed
Hopkinton-Everett	Completed
Local Protection	**Present Status**
Fitchburg	Completed
Haverhill	Completed
Lawrence	Inactive
Lowell	Completed
Nashua	Completed

c. NENYIAC Report. - The report of the New England-New York Inter-Agency Committee (NENYIAC) considered all aspects of the land and water resources of the area. The report was published as Senate Document No. 14, 85th Congress, 1st Session. Chapter XV of Part Two of the report covers the Merrimack River Basin in New Hampshire and Massachusetts. The NENYIAC Report considered the problem of flood control and determined that there was need for additional flood control measures in the basin.

8. Studies in Progress. -

a. The North Atlantic Regional Water Resources Study. - The NAR Study is one of 20 regional comprehensive water and related land resources studies being conducted throughout the United States under guidelines established by the Water Resources Council. The NAR Study was authorized by the 1965 Flood Control Act (Section 208, Public Law 89-298). The study's objective is the establishment of a broad master plan or framework to serve as a basis for future regional water resources development and management. The requirements and needs of the people of the region will be considered in analyzing water resource needs including water quality control, flood control, municipal and industrial water supply, irrigation and rural water supply, navigation, hydroelectric power, recreation, fish and wildlife and other environmental resources. These needs will be projected through the year 2020. The study began in 1969 and is scheduled for completion in 1972.

b. Northeastern United States Water Supply Study (NEWS). - The unprecedented drought that started in 1960 over the northeastern seaboard of the Nation, led Congress to authorize the Secretary of the Army, in October 1965 (P.L. 89-298), to cooperate with Federal, State and local agencies in preparing plans to meet the long-range water needs of the Northeastern United States. It anticipated that such plans may include major reservoirs, major conveyance facilities to transfer water between river basins, and major purification facilities to be constructed under Federal auspices with appropriate non-Federal financial participation. The NEWS study was initiated in 1966 and is scheduled for completion in FY 1973.

9. Current Investigations. - Studies for the project plan utilized the basic data obtained for the previous investigations. In addition, the following new data were obtained and studies made:

a. New photogrammetric maps of the reservoir areas were made and new area-capacity curves computed. A new large scale topographic survey map of the dam site was prepared.

b. All available subsurface information has been reviewed and the geological and soils investigations of foundation conditions and embankment materials are being completed.

c. Hydrologic studies have been reviewed and new studies have been made to determine the reservoir capacity, the spillway design flood and outlet requirements. The Design Memorandum on Hydrology (Revised) was prepared and submitted to the Chief of Engineers on 15 July 1971.

d. New preliminary appraisals of lands and damages to improvements in the reservoir, work and borrow areas have been completed and are reported in Section U of this Memorandum.

e. Relocation of roads within the reservoir has been discussed with State, County and Town officials. Preliminary studies of the affected roads have been made.

f. Relocations of utilities have been discussed with the owners and preliminary studies have been prepared.

10. Coordination with Other Federal and Non-Federal Agencies. -

a. Federal Power Commission. - During the preparation of the interim report of January 1965, the Federal Power Commission reviewed the power potentialities of the six proposed multiple-purpose reservoir projects on the North Nashua River tributaries and concluded that none of the six proposed reservoir projects are adapted to practicable and economic development of hydroelectric power in conjunction with other project purposes. The views of the Federal Power Commission were confirmed in letter dated 30 January 1964 which is included in Appendix C of this Memorandum.

b. U. S. Department of Health, Education and Welfare. - During the review of the 1965 Survey Report of the North Nashua River Basin, the Department of Health, Education, and Welfare, pointed out the need for providing in these projects storage for water quality (W.Q.) to supplement the waste treatment program. HEW stated that studies were then being made by their Office to determine the level of waste treatment to be required of industries and municipalities in the basin and the studies would be followed by establishment of a schedule for abatement. Upon establishing the abatement schedule, HEW intended to make firm projections of need for storage for water quality control and intended to provide

this information to this Office upon completion.

During the study of the water quality needs, the Federal Water Pollution Control Administration was transferred from HEW to the Department of the Interior. While under the Department of the Interior, the Northeast Region of FWPCA prepared and submitted to the New England Division in April 1968 a report entitled "Water Quality Control Study, North Nashua River Basin, Massachusetts."

Although the primary responsibility for water quality no longer remains with HEW, coordination with HEW with respect to health hazards has been pursued. Comments on the reformulation of the Whitmanville and Nookagee Lake projects have been requested from HEW and are included in Appendix C.

c. The Environmental Protection Agency. - With further reorganization the FWPCA became the Water Quality Office under the Environmental Protection Agency. This Office has maintained close coordination with the Regional Office. As stated in Paragraph 4 (Page 2) of Appendix A, WQO did update the minimum flow requirements based upon a more critical reach of the river. A detailed report on the results of the reformulation of the projects was sent to the Water Quality Office of the Environmental Protection Agency for review and comments.

d. Commonwealth of Massachusetts, Water Resources Commission. - During the review of the Survey Report on the North Nashua River, the Water Resources Commission on behalf of the Commonwealth of Massachusetts expressed a vital interest in the multi-purpose development proposed by the New England Division and would support "any State legislation necessary to carry out the local requirement of the project" - Appendix C, Exhibit C-3. During the period of reformulation, the Water Resources Commission reaffirmed its strong interest in the projects and specifically the need for inclusion of water quality storage - Exhibit C-4. Comments on the reformulation have been requested from the Commission.

e. Coordination with Other Federal and State Agencies. - Comments on the reformulation of the Whitmanville Lake project as well as the Nookagee Lake project were requested from the

following agencies:

Federal:

Office of Water Hygiene, EPA
Department of Housing and Urban Development
Federal Highway Administration
Department of Interior (Fish and Wildlife Service)

State:

Division of Environmental Health
Division of Fisheries and Game
Department of Natural Resources
Water Pollution Control Division

Regional:

New England Interstate Water Pollution Control Commission
New England River Basins Commission
New England Regional Commission
Montachusett Regional Planning Commission

The comments received are included in Appendix C.

11. Public Hearing. -

a. Survey Report. - A public hearing was held on 13 November 1962 in Fitchburg, Massachusetts, to determine the need for additional projects for flood control and allied purposes on the North Nashua River, Merrimack River Basin. Improvements requested by representatives of Federal, State and municipal governments included flood control dams and reservoirs and various local improvements.

b. Recent Hearings. -

(1) On 17 July 1969, an open information type meeting was held in Westminster, Massachusetts. Approximately 50 local and Fitchburg residents as well as conservation and planning board members attended. The meeting afforded an opportunity to review the Whitmanville and Nookagee project features and purposes;

touched upon the effect of withdrawal of support for the industrial water supplies; and on future planning. The hearing was well received and the attendees expressed interest in the projects and, in particular, the recreational aspects. No expressions of opposition to the projects were voiced at the meeting.

(2) A second special open information type meeting has been scheduled for November 1971 for which plans are presently being made with the cities and towns within the vicinity of the two projects.

E. LOCAL COOPERATION

12. Recreation. - Non-Federal interests are required to administer project land and water areas for recreation; pay one-half of the separable first costs of the project allocated to recreation (amount involved currently estimated as $175,000) and bear all costs of operation, maintenance, and replacement of recreation facilities (estimated as $18,000 annually). The Department of Natural Resources of the Commonwealth of Massachusetts has indicated by letter, dated 1 February 1971 (Exhibit C-5 of Appendix C) that they are interested in working out a mutually agreeable lease on the recreational area at Whitmanville Lake.

13. Flood Control & Water Quality Control. - Based upon reformulation of the projects (See Para. 51, Project Reformulation) local interests are required to: (1) protect channels downstream from encroachment, (2) be responsible for water-rights claims (3) control against removal of water in the basin. Flood control and water quality benefits are widespread and their costs are considered entirely Federal. Efforts on a local and regional basis (See Paragraph 30) demonstrate the seriousness and determination inhabitants of the basin have in cleaning up the pollution and in protecting the natural resources. Strong support for the flood and water quality control aspects has been expressed by the city of Fitchburg (Exhibit 3, Appendix A) and by the Commonwealth of Massachusetts (Exhibit C-4 and C-6 of Appendix C). Protection of the channels from encroachment is being actively pursued by numerous cities and towns along the North Nashua and Nashua River. The cities of Fitchburg and Leominster have filed requests with the Corps for flood plain management studies. The city of Nashua, New Hampshire is in the midst of rezoning which includes an

ordinance for flood plain zoning. The town of Pepperell has passed flood plain zoning by-laws. The Montachusett Regional Planning Commission has taken the position that flood plain zoning in downstream communities should be required prior to construction of the flood control projects.

F. LOCATION OF PROJECT AND TRIBUTARY AREA

14. Location of Project. - The Whitmanville Lake Project is located on the Whitman River in the Towns of Westminster and Ashburnham, Massachusetts. The Whitman River has its source in Lake Wampanoag (El. 1079 msl) in the Town of Ashburnham and flows in a southeasterly direction for nine miles to the headwaters of the North Nashua River. It has a drainage area of 27.5 square miles and a total fall of about 490 feet. The dam site is about 4 miles above the confluence of the Whitman River with the North Nashua River. The lake will extend upstream about 2.2 miles and control a drainage area at the dam site of 17.5 square miles.

15. Description of the North Nashua River Basin. - The North Nashua River Basin is situated in north-central Massachusetts in the northern portion of Worcester County. The basin encompasses three cities and seven towns lying wholly or partially within the basin. The largest urban area, Fitchburg-Leominster, is one of ten Standard Metropolitan Statistical Areas (SMSA) in Massachusetts and constitutes the major population center within the basin. The area is about 40 miles from Boston, and 25 miles from Worcester. The North Nashua River is formed at the confluence of the Whitman River with Flagg Brook in the city of Fitchburg. Worcester County, Massachusetts, at an elevation of 590 feet above mean sea level and has a total fall of 365 feet over its 18.2 miles of length. The river pursues a generally northeasterly course for about three miles into the center of Fitchburg and then turns to a generally southeasterly course for about eight miles to the USGS gage in Leominster, and thence seven miles to its confluence with the Nashua River in the Town of Lancaster. The 132 square mile watershed of the North Nashua River, contributes to the Nashua River drainage area of 530 square miles, and in turn contributes to the Merrimack River drainage area of about 5,000 square miles.

G. RECOMMENDED PROJECT PLAN

16. Recommended Project Plan. - The recommended project plan provides for a rolled earthfill dam with rock protection, 1,430 feet long and 76 feet in height above the stream bed. A chute spillway with a 150 foot uncontrolled concrete weir will be located in a rock cut in the left abutment with the spillway crest at elevation 845.0. The outlet works will consist of a 4 foot by 5 foot cut-and-cover concrete conduit founded on rock in the left abutment of the dam.

The Westminster Street-South Ashburnham Road, a bituminous surface county road on the left bank of the river valley in the reservoir, will require relocating and raising above the guide taking line, a total of about 2.4 miles. The intersections of North Common Road with South Ashburnham Road will be modified to provide a smooth and safe transition for traffic; particularly for the numerous school buses emanating from the regional high school located at the northwest end of the reservoir. A segment of Bragg High Road, between the existing and the new location of South Ashburnham Road, will be abandoned. Intersections of Barrel Road, Needham Road, Platts Road and the access road to the regional high school with the relocated South Ashburnham Road will be modified to provide suitable transitions.

Electric and telephone lines will be relocated along the relocated road. Approximately 1,000 feet of water line will be raised on Westminster Street where the road surface is to be raised. The raising of the water line is necessary to make it accessible for maintenance purposes.

The structures, improvements, and relocations are described in detail in Section M. - DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS. The various structures and topography at the site, and proposed alignments of road relocations are shown in Plate Nos. 2-2 and 2-3.

H. DEPARTURE FROM PROJECT DOCUMENT PLAN

17. Project Document Plan. - The Whitmanville Lake Project, along with the Nookagee Lake, Monoosnoc Lake and Phillips Dam, was authorized by the Flood Control Act of 7 November 1966 substantially in accordance with the recommendations of the Chief of Engineers as presented in Senate Document No. 113, 89th Congress, 2nd Session. The plan proposed that the Whitmanville project be authorized with flood control and industrial water supply as project purposes. The flood protection would consist of 6,700 acre-feet, equivalent to 7.2 inches of runoff from a drainage area of 17.5 square miles. Industrial water supply storage of 2,650 acre-feet (2.8 inches of runoff) included 1,150 acre-feet of industrial water the project was obligated to replace as a result of inundation of the existing Westminster water supply reservoir. Using topographical data derived from USGS quadrangle sheets, the required capacity set the spillway crest elevation at 845 feet mean sea level.

18. Departure from Project Document Plan.

a. Reformulation. - As a result of the reformulation of the Whitmanville project, as stated in Section 0 - PROJECT REFORMULATION AND EVALUATION, the approved changes to the project include:

(1) Deletion of the industrial water purpose,

(2) Inclusion of 800 acre-feet of seasonal storage for low flow augmentation for water quality, and

(3) Addition of the main recreational development at the Whitmanville site (previously located at the Nookagee Lake site). Recreational development includes 1,400 acre-feet seasonal use of flood control storage of which 800 acre-feet will be jointly used for water quality control.

b. Planning and Design. - In addition to the changes in project purposes for Whitmanville as stated above, the following modifications and changes from the approved document plan (Senate Document No. 113) have been made based upon development of detailed planning and design studies.

(1) The area capacity curves developed from the new plane table maps of the reservoir indicate that for full pool (El. 845.0) the storage volume was found to be 1,500 acre-feet (16%) less than that determined in the survey report.

(2) The top elevation of the dam has been raised from elevation 860.0 to 860.5 mean sea level, due to freeboard requirement.

(3) The outlet controls have been changed from two independent works to a single multi-purpose outlet works; due to changes in project purposes and for economic reasons.

(4) Economic studies of spillways of various lengths indicated that a chute spillway of 150 foot length should be adopted.

(5) Subsurface explorations, strength of the impervious material and embankment design analysis indicate that the upstream slope has to be flattened and the downstream slope would require a 100 foot berm.

(6) From field surveys it was determined that the existing ground in the vicinity of the Boston and Maine Railroad was at an elevation where the flank dike was no longer required.

(7) The existing Westminster Dam, located 3/4 miles upstream of the Whitmanville Dam site, will be utilized to establish a two pool operation rather than removed as previously planned.

19. Reservoir Capacity. - Flood control reservoirs in New England, built by the Corps of Engineers, generally have capacities equivalent to 6 to 8 inches of runoff from the contributing drainage areas. The exact amount of storage is dependent on the geographic location of the reservoir and physical limitations at the site. This amount of storage is required for effective control of Standard Project Flood and also for control of recurrence of historical floods, such as, the November 1927, March 1936, September 1938, and more recently the August 1955 events. Real Estate restrictions (See Para. 51) made it uneconomical to include the full 8" of storage, consequently, a lesser amount (7.2 inches) was recommended for authorization.

Based on more detailed photogrammetric mapping, the recalculated capacity for Whitmanville Lake at full pool (El. 845.0 msl) was found to be 7,850 acre-feet instead of 9,350 as estimated in the survey report. The decrease in capacity of 1,500 acre-feet was approximately equivalent to the 1,530 acre-feet of new industrial water supply storage originally authorized. The result of this development meant that by holding the spillway crest at elevation 845.0, the capacity is sufficient to accommodate the authorized flood control storage of 6,700 acre-feet (7.2 inches of runoff) as well as compensate for the existing storage of 1,150 acre-feet in Westminster Reservoir. The additional storage needs for the supplementary purposes of recreation and water quality will be by seasonal encroachment on part of the flood control storage.

20. Spillway Design Flood. - The spillway design storm was based on the probable maximum precipitation over a 17.5 square mile drainage area. The depth of rainfall over the Whitman River watershed upstream of the damsite totaled 21.4 inches. Losses were assumed at a rate of 0.2 inches per three-hour period resulting in a rainfall excess of 19.8 inches. The rainfall excess values were applied to the adopted unit hydrograph for 13.7 square miles of land area. To this was added the direct rainfall on the reservoir itself plus the

routed outflow from Lake Wampanoag, resulting in an inflow hydrograph with a peak of 25,000 cfs. With a spillway length of 150 feet and a discharge coefficient varying from 3.1 to 4.0, the spillway design hydrograph was routed through the reservoir. The flood was routed assuming two starting elevations: (a) reservoir at 50% flood control capacity (El. 834.8), and (b) reservoir at spillway crest El. 845.5. For both conditions, the flood control conduit outlet was assumed inoperative. For the selected spillway length of 150 feet, the resulting surcharges for the two conditions stated above were 9.6 and 10.2 feet, respectively.

21. Freeboard and Top of Dam. - In accordance with EC 1110-2-27, a freeboard of 5.0 feet was allowed for the above condition (a) and 3.0 feet was allowed for condition (b). Allowing for appropriate approach losses, the top of dam required for condition (a) was determined to be 860.5 and for (b) 859.3. The adopted elevation for the top of dam was 860.5. The design spillway discharge was determined to be 19,300 cfs.

Summarized:	Case (a)	Case (b)
Reservoir elevation at start of flood	834.8	845.0
Spillway crest elevation (msl)	845.0	845.0
Surcharge (feet)	9.6	10.2
Friction loss, reservoir to spillway (feet)	0.9	1.1
Minimum freeboard (feet) Top of Dam	5.0	3.0
	860.5	859.3

22. Outlets. - The outlet works for Whitmanville Lake will consist of a gated intake tower with a primary flood control outlet at the bottom and a secondary dual level outlet to permit selective withdrawal of water quality releases.

A 4 x 5 foot conduit was selected as the primary outlet to handle (a) normal stream flows, (b) pass discharges for regulation of the reservoir during floods, (c) permit evacuation of the flood storage within a reasonable period of time and (d) pass a flood of reasonable size during construction. This conduit will have a capacity of approximately 500 cfs with the pool at 817.5 and 725 cfs with full pool.

The secondary dual level outlets are tentatively planned to have a capacity range of 20 to 30 cfs. The outlet will adequately handle the releases for industrial water as well as the releases

of water quality.

23. Channel Capacity. - The channel capacity of the Whitman River, downstream of the dam, is estimated to be not over 500 cfs.

24. Supplemental Presentation. - Hydrologic analysis for the subject Whitmanville and Nookagee projects was presented in greater detail in Design Memorandum No. 1, Hydrology (Revised) submitted on 15 July 1971. Detailed hydraulic analysis will be presented in Design Memorandum No. 9 to be submitted at a later date.

J. WATER QUALITY CONTROL

25. General. - Serious pollution exists in the North Nashua River from the mouth of the Whitman River in Fitchburg to the confluence of the North and South Branches of the Nashua River At Lancaster. Discharges from the paper mills and sewage treatment plants, particularly at Fitchburg and Leominster, contribute to the problem by causing high bacterial densities with suspended solids, nutrients, and organic matter which increase biochemical oxygen demand. The waste discharges far exceed the assimilative capacity of the stream. As a consequence, the water quality is badly degraded, resulting in obnoxious and nuisance conditions. The tributary flows upstream of the waste discharges are generally of excellent quality and a good environment for biological life.

26. Comprehensive Water Quality Control Study. - At the request of the Corps of Engineers the Water Quality Office of the Environmental Protection Agency investigated the need for regulations of stream-flow for water quality purposes in the North Nashua River Basin. Their conclusions were published in a report dated April 1968 entitled "Water Quality Control Study, North Nashua River Basin", and summarized the water quality problem as:

a. The North Nashua River is in a nuisance condition below Snows Mill Pond, mainly due to industrial and municipal pollution arising in Fitchburg and Leominster. Allowing for industrial and population growth, it is foreseen that water quality will not meet standards set by the Commonwealth of Massachusetts even if all waste receives a high degree of treatment at its source.

b. Flow in the North Nashua River Basin is now regulated privately for industrial water supply purposes. Additional low flow regulation by the authorized reservoirs for purposes other than water supply would, in conjunction with adequate treatment of wastes at their source and continued regulation of existing reservoirs, result in meeting the approved state standards and in maintaining a suitable water quality for the foreseeable future.

c. Benefits due to the improved quality would be widespread and of major economic significance to the entire region. They would include enhanced real estate values, an improved aquatic environment, enhanced recreational opportunities and an upgrading of the general economy of the region.

d. Facilities sufficient to maintain minimum flow requirements, should be incorporated in the water resources development plan for the North Nashua River Basin.

27. Water Quality Standards. - Water quality standards, as recommended by the Massachusetts Division of Water Pollution Control and as approved by the Massachusetts Water Resources Commission, and the Secretary of the Interior, have been established for the North Nashua River. These standards require that secondary treatment, or its industrial waste equivalent, be provided for all wastes on the North Nashua River; that certain watersheds designated for water supply shall meet Class A criteria; that all other tributaries shall meet at least Class B criteria and that the mainstem of the North Nashua shall conform to Class C criteria. Class C requires a dissolved oxygen content of not less than 5 mg/l during at least 16 hours of any 24-hour period nor less than 3 mg/l at any time. Complete data on classification criteria of the Commonwealth of Massachusetts are given in Appendix B and locations in the North Nashua Basin are shown on Figure 1.

28. Future Waste Loading. - Future waste loadings in the years of 2020 and 2070 are expected to be geographically similar to that of the present. The major contributions are expected to be from the industrial pollution sources and to a lesser degree from cities and towns along the North Nashua River. The implementation program to achieve the water quality standards will result in a

marked reduction of pollutants discharged to the stream. But even though a high degree of future treatment is achieved, it can be expected that treated residual waste loadings to the river, though much less than at present, will increase with time due to industrial and population growth.

29. Augmentation Requirements. - The minimum flow requirements for water quality control in the North Nashua River were presented to the Corps in the 1968 report of WQO. The report established requirements at the Leominster Gage and were subsequently updated based upon more critical measurements at Arden Mill Dam upstream from the Leominster Gage (Plate 2-1). With the targets set by WQO, the New England Division determined the storage and releases necessary to meet these requirements. The study revealed that storage of 3,800 acre-feet would provide, with 95% dependability, the flows needed for water quality control. A detailed analysis of the water quality requirements were included in the Hydrology Memorandum No. 1. (Revised). The manner of operating the water quality releases and the relationship of the releases with the gaging stations and the industrial water users are presented in Paragraph 5, Page 8 of the "Justification" report included as Appendix A.

30. Support for Water Quality. - The most ardent support for the cleanup of the North Nashua and Nashua Rivers has emanated from the Nashua River Watershed Association (NRWA). With dedication and determination, this group (total membership 1970 - 357) has successfully obtained the cooperation and active support of conservationists, local and state agencies and industry towards obtaining their goal of turning the basin from an open sewer to a viable public waterway and attractive recreational area. The three prong objectives of this group include: terminate pollution, protect the river and adjacent land from excessive development (establish a greenbelt), enhance recreation and conservation aspects.

In addition to the Environmental Protection Agency and the Nashua River Watershed Association, expressions of support for improved water quality have been made by:

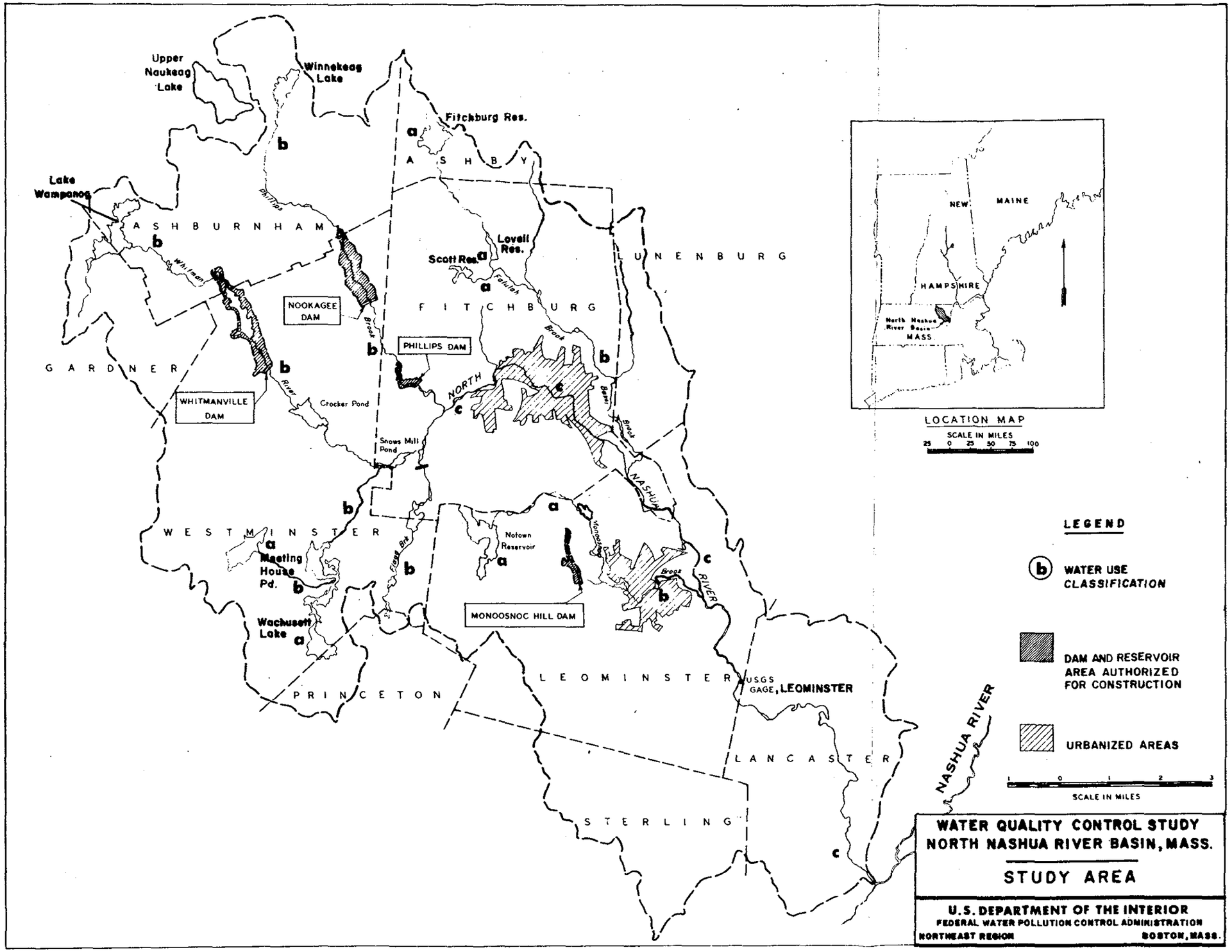

Upper Naukeag Lake
Winnekeag Lake
Fitchburg Res.
Lake Wampanoag
ASHBURNHAM
ASHBY
Phillips Brook
Whitman
NOOKAGEE DAM
Scott Res.
Lovell Res.
Falulah Brook
UNENBURG
FITCHBURG
GARDNER
PHILLIPS DAM
WHITMANVILLE DAM
River
Crocker Pond
North Nashua River
Snows Mill Pond
Beaver Brook
NASHUA
WESTMINSTER
Meeting House Pd.
Flood Brook
Notown Reservoir
Hannah Brook
Brook
RIVER
Wachusett Lake
MONOOSNOC HILL DAM
PRINCETON
LEOMINSTER
USGS GAGE, LEOMINSTER
LANCASTER
NASHUA RIVER
STERLING
NEW HAMPSHIRE
MAINE
MASS
North Nashua River Basin
LOCATION MAP
SCALE IN MILES
25 0 25 50 75 100
LEGEND
(b) WATER USE CLASSIFICATION
DAM AND RESERVOIR AREA AUTHORIZED FOR CONSTRUCTION
URBANIZED AREAS
1 0 1 2 3
SCALE IN MILES
WATER QUALITY CONTROL STUDY
NORTH NASHUA RIVER BASIN, MASS.
STUDY AREA
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
NORTHEAST REGION
BOSTON, MASS.

FIGURE 1

Senator Edward M. Kennedy

Congressman Robert F. Drinan

Commonwealth of Massachusetts
Water Pollution Control Division

New England River Basins Commission

Cities of Fitchburg and Leominster

Nashua River Reservoir Company

Montachusett Regional Planning Commission

31. Nashua River Model River Basin Demonstration Project. - The New England Regional Commission, established by the 1965 Public Works and Economic Development Act, has sponsored a Nashua River Model Basin Project. The project has the objective of demonstrating to the rest of the nation that with proper planning, coordination and reasonable financial backing, an open sewer (North Nashua and Nashua River) can be converted to a viable public waterway. The project is being planned by the Program Management Group which is chaired and staffed by the New England River Basins Commission and includes representatives from the Massachusetts Division of Water Pollution Control, the New Hampshire Water Supply and Pollution Control Commission, the New England Interstate Pollution Control Commission and WQO. The New England Regional Commission in December 1970 allocated $1.5 million of its Fiscal Year 1971 budget to support this project. An additional $1.5 million of the Fiscal Year 1972 budget is expected to go to the project. The Program Management Group has indicated that even in their early stage of planning, they are aware of the need of flow augmentation for water quality from Whitmanville and Nookagee in order to reach their objective.

32. Progress in Abating Pollution. - Highlights of progress made by communities on the North Nashua River in combating pollution include:

a. Fitchburg - Weyerhaeuser, Fitchburg, and Fitchburg Paper signed contracts describing their financial agreement with each other to build the West Fitchburg treatment plant. This

agreement will be sent to State and Federal water pollution control agencies for their approvals. Final plans for the plant were completed in June 1971. The plant will treat its waste with activated carbon, producing a very high quality effluent. Final plans for the East Fitchburg plant have been completed and submitted to the Division of Water Pollution Control for approval and funding. The City of Fitchburg and its participating industries expect to break ground this summer and to have both plants in operation in 1973.

b. Leominster - Construction has begun on the rehabilitation of Leominster's old sewage treatment facility. Work will be completed by August 1971. This plant will handle domestic waste plus the pretreated waste from Bordon Chemical and Forster Grant Companies.

c. Westminster - Advanced Coatings and Decotone Industries have completed the treatment facilities required of them by the state to produce an effluent which will meet river quality standards.

d. Remaining Communities - Impressive gains have also been made by communities along the Nashua River including Lancaster, Clinton, Groton, Pepperell, Ayer, and Nashua.

K. GEOLOGY

33. General. - The Whitman River flows through the central upland of Massachusetts, a region of low to moderate relief underlain by crystalline rocks. The topography is rough and irregular largely as a result of glacial erosion and deposition. Long, broken-crested ridges and steep, knobby hills rise above fairly broad but winding and rough-sided valleys. The upper slopes of the hills are blanketed by generally thin deposits of till. Drumlins, elliptical hills composed almost entirely of till, form prominent features throughout the area. In the valleys the till is usually buried under outwash deposits which form extensive flat valley plains and terraces along the valley sides. The bedrock of the region consists of a series of closely folded carboniferous rocks, mainly schist and gneiss with large areas of granite and pegmatite. The folds trend generally north-south.

34. Foundation Exploration. - Investigations of survey report scope were initiated at the site in April 1963. Three borings were made and the results of the investigations were presented in the "Water Resource Development Plan, North Nashua River Basin, Merrimack River, Massachusetts, Appendix E." Detailed investigations for preparation of final designs were begun in March 1969. Fifty-three foundation test borings, including three borings to obtain undisturbed samples for tests, have been completed to date under the current program. The location of all the completed borings is shown on Plan of Foundation Explorations, Plate 2-8.

35. Site Geology - At the site the Whitman River flows in a shallow channel along the eastern border of the relatively wide, flat bottomed valley. Both immediately upstream and downstream, however, the valley bottom is constricted by extensive but rough and irregular outwash deposits. On the abutments, the outwash deposits form narrow terraces on the lower slopes above which the abutments rise steeply to heights above top of dam. In the valley bottom as shown on Geologic-Log Sections, Plate 2-9, the overburden ranges in thickness from about 10 feet to more than 50 feet. The overburden in the valley consists generally of outwash composed of roughly stratified and lensed sands and gravels with a few local, thin lenses of silt. The outwash is underlain generally by till and boulders which extend to rock. The till is characteristically variable but consists generally of silty and gravelly sands and silty gravels. On the left

abutment the overburden is 10 to 15 feet thick and consists mainly of till with superficial outwash on the lower slopes. Numerous boulders, some of very large size, occur thickly scattered and in local boulder pavements throughout the abutment. On the right abutment the overburden is thicker ranging from about 40 feet under the lower terrace to 20 feet in the upper reaches of the abutment. Under the lower terrace the overburden consists of approximately 25 feet of outwash sands and gravels underlain by till to bedrock. The outwash pinches out on the upper slopes and is only about 3 feet thick overlying the till.

Bedrock does not outcrop in the immediate vicinity of the site but rock cores from borings indicate that the bedrock consists mainly of granite gneiss with pegmatite occurring both in extensive areas and in irregular masses, dikes and stringers. Diabase apparently occurring as thin dikes dipping at high angles also was encountered at a few locations. The gneiss is light to dark gray, generally coarse-grained and hard. Foliation, although variable and locally obscure, dips generally at low angles. The gneiss is generally slightly weathered along scattered joints except in local but widespread areas where weathering has occurred along numerous closely-spaced joints and seams to depths up to 20 feet below the bedrock surface. The pegmatite is very coarse-grained, light gray or buff except where weathered to rusty yellow. The pegmatite is generally slightly weathered throughout but it is also commonly badly weathered and broken along numerous, very irregular, hackly joints. The diabase is very dark gray to black, very fine-grained, hard and generally fresh with only nominal weathering along very closely spaced joints. Breccia and gouge indicating faulting in the rock were encountered in several borings on the left abutment in the vicinity of the spillway.

L. OTHER SOLUTIONS CONSIDERED

36. Flood Problem. - Alleviation of the flood problem could be accomplished by either construction of flood control reservoirs; channel diversion and relocations; levees and improved channels for the protection of local damage centers; restrictive zoning measures with evacuation of the flood plain, or a combination of reservoirs, local protection and restrictive flood plain zoning.

Utilization of reservoirs alone to provide flood protection for communities along the North Nashua as well as Nashua Rivers was determined to be impractical due to prohibitive cost and the limited sites available for such reservoirs. The use of diversion tunnels and closed conduits although less disruptive to existing facilities, bridges, buildings, etc. was found to be excessive in cost. Construction of floodwalls and levees alone to control floods primarily in Fitchburg and Leominster was found prohibitive due to extensive development built along the river's edges. Restrictive zoning or evacuation of the flood plains alone was considered impractical in the primary flood prone areas of Fitchburg and Leominster.

The water resources development plan recommended for the North Nashua River incorporated the combination of reservoirs, channel improvements and zoning to accomplish its objective. With a minimum number of reservoirs (4) and three channel improvement projects the industrial heartland of the cities would obtain a high degree of protection. For the non-developed and rural areas the plan recommended that encroachment lines downstream of the dams be established. This Division has actively urged that flood plain zoning be established not only for communities along the North Nashua but also for communities on the Nashua River.

37. Water Quality Problem. - The Federal Water Pollution Control Administration in its 1968 study considered possible alternatives to low flow augmentation. It included: (a) reaeration of the stream and or effluents and (b) tertiary waste treatment. Other alternates such as waste disposal underground and waste holding in lagoons for discharge during favorable flow conditions were considered impractical because of the large volumes of plant discharge and the inordinate size of facilities that would be required. The Weyerhaeuser operation alone has a discharge rate of over 12 mgd. In addition, flows in the river must be maintained to provide process

water for downstream industries. The need to reuse the water at downstream locations also makes it impractical to collect all wastes for long distance transmission to treatment and discharge to a larger watercourse.

The study concluded that the alternates could not provide benefits equivalent to low flow augmentation. Low flow augmentation in addition to maintaining desired BOD and dissolved oxygen levels provides dilution for non-degradable pollutants, better stream velocities to inhibit obnoxious aquatic growth, higher water levels for improved aesthetic and recreation enjoyment, a stabilizing influence for all downstream reaches regardless of loading conditions which may not follow a predictable pattern, and a smaller likelihood of being rendered obsolete by changing needs and technology.

M. DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

38. General. - A description of each of the principal elements of the proposed plan for the Whitmanville Lake project is presented in the following paragraphs. Studies to develop design details for each element are under way and will be presented in subsequent Design Memoranda.

39. Dam Embankment. - The project plan provides for the construction of a zoned rolled earth fill dam with upstream and downstream rock slope protection. A profile of the dam and tentative embankment sections are shown on Plate Nos. 2-4 and 2-5. Major factors influencing embankment design are the foundation conditions and the availability and characteristics of embankment materials. Suitable materials from the required earth excavations will be utilized in constructing the pervious and random fill zones of the embankment. The impervious fill zone will be constructed of material obtained from borrow excavations in a glacial till deposit upstream of the damsite and to the left of the reservoir. The outside embankment slopes have been established on the basis of embankment stability studies including shear tests. Seepage through the embankment foundation will be controlled by an impervious foundation cut-off extended to grouted bedrock. Details of the embankment design will be presented in Design Memorandum No. 8, Embankments and Foundations.

40. Spillway. - The spillway will be chute type located in the left abutment. For details, see Plate Nos. 2-3 and 2-7. The weir will be a concrete ogee section founded on rock at the high point of the channel. The length of the weir will be 150 feet at spillway crest elevation 845.0 feet, mean sea level. The height of the concrete weir above the spillway approach channel will be 5 feet, making the maximum elevation of the approach channel 840.0 feet, mean sea level, at the upstream face of the spillway weir. The excavated approach channel will slope down into the reservoir for drainage. The spillway chute or discharge channel, excavated in earth and rock, will be of the convergent and parallel type and will be about 750 feet long. It will slope from invert elevation 837.25 at the weir at a 9% grade for 100 feet, then at a 10% slope for a distance of 153

feet and continuing at a 30% slope from this point for 96 feet (784. 0), thence to elevation 783. 0 in 57 feet at which it will be level at elevation 783. 0 ft., m. s. l. for a distance of about 200 feet and pass under the existing bridge at old North Common Road, where it will enter an existing branch of the Whitman River.

41. Outlet Works. - The outlet works will be located near the left abutment, under the dam, and will consist of an inlet channel, an intake tower, a conduit on rock under the dam, an outlet structure, and an outlet channel. Details of the outlet works are shown on Plate No. 2-6.

a. Inlet Channel. - A 237-foot long intake channel of varying width will be excavated, with bottom elevation varying from 787. 0 to 790. 0 feet, mean sea level.

b. Intake Tower and Operating House. - The intake tower will house the flood control and water quality control outlet works. It will be a dry well type structure about 95 feet in height and will be located about 232 feet upstream from the centerline of the dam. A service bridge will provide access from the top of dam. Plan and profile views of the intake tower are shown on Plates 2-3 and 2-6, respectively.

The intake structure at the base of the tower will have an invert elevation of 790. 0 ft., m. s. l., and will consist of a 10-foot high by 17-foot wide trash bar structure, two rectangular entrance conduits 3 feet wide by 4 feet high and a vertical slide flood control gate of the same dimensions in each bay. A vent pipe will be installed within the tower to satisfy the air demand at each gate when operating at partial openings. Provisions will be included on the upstream face of the tower to permit lowering a steel bulkhead for repair or emergency closure of each entrance.

The water quality control outlet works will consist of two 24-inch diameter inlets with 24-inch butterfly valves, a 36-inch diameter control well and a 20-inch diameter conduit, controlled by a 20-inch butterfly valve, which discharges into the flood control conduit at a point downstream from the service gates. The inlets will be at elevations 805 and 817 ft., m. s. l.

The intake tower will contain two floors: (1) the heater room floor, and (2) the operating floor. The operating room will house the high pressure oil hydraulic system for operation of the gates, a continuous waterstage recorder, an electrical switchboard, and an emergency diesel engine generator. The heater room floor will contain a forced warm air heating system and oil pump and motor standby unit. The gate chamber at elevation 798. 5 will contain two individual hydraulically operated vertical slide service gates, and a sump pump located in a well. Electric power will normally be obtained from commercial sources.

c. Conduit and Transition. - Beginning at a point approximately 13 feet downstream from the centerline of service gates, a transition section approximately 40 feet in length will converge the two inlet conduits into a single 4' x 5' outlet conduit constructed of reinforced concrete. The conduit will be founded on rock under the dam and will have a total length of approximately 340 feet. It will slope at about 0. 6 percent from the end of the transition to the outlet at elevation 788. 0 ft., m. s. l.

d. Outlet Channel. - The outlet channel, excavated in rock will be 15 feet wide and approximately 240 feet long, at which point it merges into a common channel with the spillway. The initial 50-foot segment of the channel contains a concrete stilling basin with an invert transition from elevation 788. 0 to 779. 0. The channel is depressed 1 foot to elevation 778. 0 adjacent to the stilling basin and rises to elevation 781. 5 in 17. 5 feet at which point the channel slopes downward to the spillway channel at a rate of 0. 5%.

42. Existing Westminster Dam -

a. General. - The Westminster Dam is located about 3/4 miles upstream of the proposed Whitmanville Dam. The existing dam is currently owned by the Nashua River Reservoir Company but will be acquired, operated and maintained by the Corps of Engineers. The dam will be used to avoid drawdowns of the recreation pool greater than 1. 5 feet. Flashboards will be removed to elevation 825. 1 for operational purposes.

b. Dam Features. - The embankment of the existing Westminster Dam is approximately 1, 000 feet long, with the height generally less than 10 feet except for a reach of 330 feet where the maximum depth is 30 feet. The downstream slope is grass covered whereas the upstream is riprapped. The outlet works consist of an upstream intake tower and discharge conduits consisting of two 24-inch diameter gated cast iron pipes. The spillway is of concrete, chute type and approximately 50 feet wide. Elevation of features of the dam include:

Spillway Crest	824. 4
Top of Flashboards	826. 6
Top of Dam	832. 3

Additional information on the Westminster Dam will be included in Design Memorandum No. 8, Embankments and Foundations.

43. Reservoir Clearing and Stripping. - No clearing is contemplated for the perimeter of the existing Westminster Lake except for recreation facilities. The portion of the reservoir between the new dam and the existing Westminster Dam will be cleared and stripped below elevation 827. 0 (0. 4 of a foot above maximum pool elevation). Normal clearing to a point 3 feet above this pool is not recommended for the lower pool since it will not be compatible with the upper pool and would be aesthetically displeasing. Clearing to elevation 827 is expected to result in some tree kill due to the change in water table and disturbance of the ecological balance. Trees affected will be removed as part of the normal maintenance of the lake. The area to be cleared and stripped is estimated to be approximately 70 acres consisting of half wooded and half brush land. The extent of stripping will encompass the removal of organic material, including topsoil, which would degrade the quality of water below present yield quality. The existing reservoir was stripped of organic material during construction.

44. Access. - Access to the top of the dam will be from a roadway leading from the old North Common Road to the right abutment of the dam. This roadway will be 16 feet wide and 970 feet long, and will include a turnaround area on the right abutment. An access ramp on the left abutment will serve as a service route to the spillway approach channel, upstream berm at elevation 830.5 and to the base of the intake tower.

45. Utilities. - Telephone and electric service to the administrative facilities and dam will be from South Ashburnham Road to North Common Road then along the access road.

46. Administrative Facilities and Utilities. - A combined utility building and garage, 32 feet by 75 feet, will be constructed downstream of the dam along the access road, see Plate No. 2-3. The building will include office, toilets, heater room, workshop and garage facilities.

47. Housing Facilities. - The minimum housing facilities considered necessary for this installation are living quarters for the damtender. Locating the damtender's residence off the access road yet close to the dam is necessary owing to the need to operate the gates on short notice at any hour of the dam as a result in changes in demand for industrial water releases. In addition, locating the quarters close to the dam, will facilitate communications during emergencies and will minimize vandalism of Government property.

N. INSTRUMENTATION OF DAM

48. General. - The instrumentation of the project will be in accordance with ER 1110-2-100 and EM 1110-2-4300. The height of the structure above sound rock will vary from 10 feet to a maximum of 125 feet.

49. Settlements. - Except for the foundation silt layer material, the foundation materials for the embankment are of the type normally exhibiting low compressibility. Settlements in the foundation silt layer will be limited due to the thinness of the strata and will occur principally during construction. Settlements in the impervious fill will be practically completed during construction.

50. Instrumentation. - Four survey monuments will be installed immediately downstream of the embankment as will be shown in the Embankment and Foundation Memorandum No. 8. These will serve as reference points to monitor any movements that might occur along the foundation silt layer during embankment construction. An additional monument will be installed in the upstream slope of the embankment at the service bridge pier site to allow observation of any movements that might take place during embankment construction.

O. PROJECT REFORMULATION AND EVALUATION

51. Project Reformulation. - During the review of the 1965 Survey Report of the North Nashua River Basin, the Department of Health, Education and Welfare pointed out the need for providing in these projects storage for water quality to supplement the waste treatment program. HEW stated that their studies "indicated that presently available treatment methods cannot alone control the polluted condition of the stream" (North Nashua River) and "even partial provisions for stream flow regulation would result in substantial quality improvement with attendant benefits within the study area". In response, the Chief of Engineers assured HEW that "prior to initiation of construction, studies will be made concerning the need for storage for water quality control".

In September 1969, the local interests, through the Mayor of the city of Fitchburg, Massachusetts, withdrew their support for the water supply aspects of both the Whitmanville and Nookagee Lake projects. It should be noted that at Whitmanville, the withdrawal of support pertained to the additional industrial water contemplated above and beyond the amount the project was obligated to replace as a result of inundation of the existing Westminster water supply reservoir. As a result of the withdrawal of support for the water supply aspects and the requirement to determine the need for storage for water quality, this office initiated a restudy of the purposes for both the Whitmanville and Nookagee projects.

Since the issuance of the 1965 Survey Report of the North Nashua River Basin, the Water Quality Office of the Environmental Protection Agency has set up minimum flow requirements for water quality control in the North Nashua River. With the targets set by the WQO, the New England Division determined the storage and releases necessary to meet these requirements. The study revealed that impoundment of 3,800 acre-feet would provide the water needed for flow augmentation for water quality with 95% dependability.

In the reformulation of the projects it was noted that the Whitmanville site offered little flexibility due to restrictions. One restriction, the regional high school, was built at an elevation which would not permit, economically, raising the dam. Accordingly, Nookagee had to provide the bulk of the storage for water quality. Six plans were derived, studied and assessed. During the period of assessment, it became evident that the magnitude of drawdowns at the Nookagee site would limit the extent of recreational development at that site. Releases from the reservoir for water quality would come at the time when the recreational demands would be the greatest and based upon past experience, drawdowns greater than 5 feet are considered excessive and detrimental to recreation by exposing large unsightly areas along the shoreline. Studies revealed that the drawdowns at Nookagee could be as much as 15 feet. The drawdown analysis terminated with the conclusion that the most favorable site for major recreation development would be at Whitmanville. Stability of the recreation pool at Whitmanville would be subject to demands for water quality releases as well as releases for industrial water equivalent in amount to storage in the existing privately owned Westminster Reservoir. However, to stabilize the recreation pool at Whitmanville, it was concluded that all water

quality releases during the recreation season would be made from Nookagee. After Labor Day the releases from Nookagee would be stopped and the water quality demands would be met by Whitmanville. Fluctuation of the recreation pool stemming from the demands of the industrial water users would be eliminated by the operation of a two-pool system. Two pools would be created by utilizing the existing Westminster Dam presently located 3/4 miles upstream of the new Whitmanville Dam. It is envisioned that the pool behind the existing dam would become the recreation pool and the storage between the new and existing dams would be used basically to meet the demands of the industrial water users. Present plans envision operating the two-pool system by:

a. Satisfying the initial demands for industrial water by a drawdown of 1.5 feet from both pools (i.e., drawdown from El. 826.6 to El. 825.1).

b. Meet supplementary demands for industrial water with the storage between the two dams.

The analysis concluded that the most efficient and least disruptive (environmentally) means to implement development of the water resource plan, as previously authorized by Congress, was by construction of a multi-purpose dam and lake at Whitmanville, and a dual-purpose project at Nookagee.

The following summarizes the revised plan:

Whitmanville Lake. Total storage capacity of 7,850 acre-feet, equivalent to 8.4 inches of runoff. The total storage has allocations of: 1,150 acre-feet (1.2 inches) to replace existing water supply at Westminster Reservoir which will be inundated by the dam; 5,300 acre-feet (5.7 inches) for flood control; and 1,400 acre-feet (1.5 inches) seasonal joint-use for flood control, recreation and water quality. Operationally the full flood control storage of 6,700 acre-feet will be available from November through March. Toward the end of the spring runoff in April, a recreation pool would be established by retaining 1,400 acre-feet within the flood control zone. This seasonal pool would be retained until the close of the recreation season in September. At that time the pool would be lowered to provide full flood control storage. Release from the seasonal pool would be utilized to meet the water quality demands for September and October.

Nookagee Lake. Total storage capacity of 8,400 acre-feet equivalent to 14.6 inches of runoff. The total storage includes allocations of: 700 acre-feet (1.2 inches) for conservation storage to serve as a minimum winter pool; 3,000 acre-feet (5.2 inches) for water quality storage; and 4,700 acre-feet (8.2 inches) for year round flood control.

A schematic diagram of the reservoir system is shown by Figure 2.

As a result of the reformulation, the Division Engineer recommended that the assurances to be furnished by the non-Federal interests be modified for the Whitmanville and Nookagee projects such that responsible non-Federal interests are required to give assurances satisfactory to the Secretary of the Army that they will:

a. In accordance with the Federal Water Project Recreation Act of 1965:

(1) Administer project land and water areas for recreation and fish and wildlife enhancement;

(2) Pay, contribute in kind, or repay (which may be through user fees) with interest, one-half of the separable first costs of the reservoir projects allocated to recreation and fish and wildlife enhancement, the amount involved being currently estimated as follows:

Reservoir	Amount
Whitmanville	$175,000

(3) Bear all costs of operation, maintenance, and replacement of recreation and fish and wildife lands and facilities, the amounts involved being currently estimated on an average annual basis as follows:

Reservoir	Amount
Whitmanville	$18,000

Provided that the sizing and responsibility for development, operation, maintenance, and replacement of the recreation and fish and wildlife enhancement features of the reservoirs may be modified in accordance with the alternative provided in the proposed Federal Water Project Recreation Act cited above, depending upon the intentions of local interests regarding participation in the costs of these features at the time of reservoir construction and subsequent thereto, and that appropriate adjustments reflecting such modifications may be made in the allocation of costs to other project purposes;

b. Protect channels downstream of the reservoirs from encroachments which would adversely affect operation of the system;

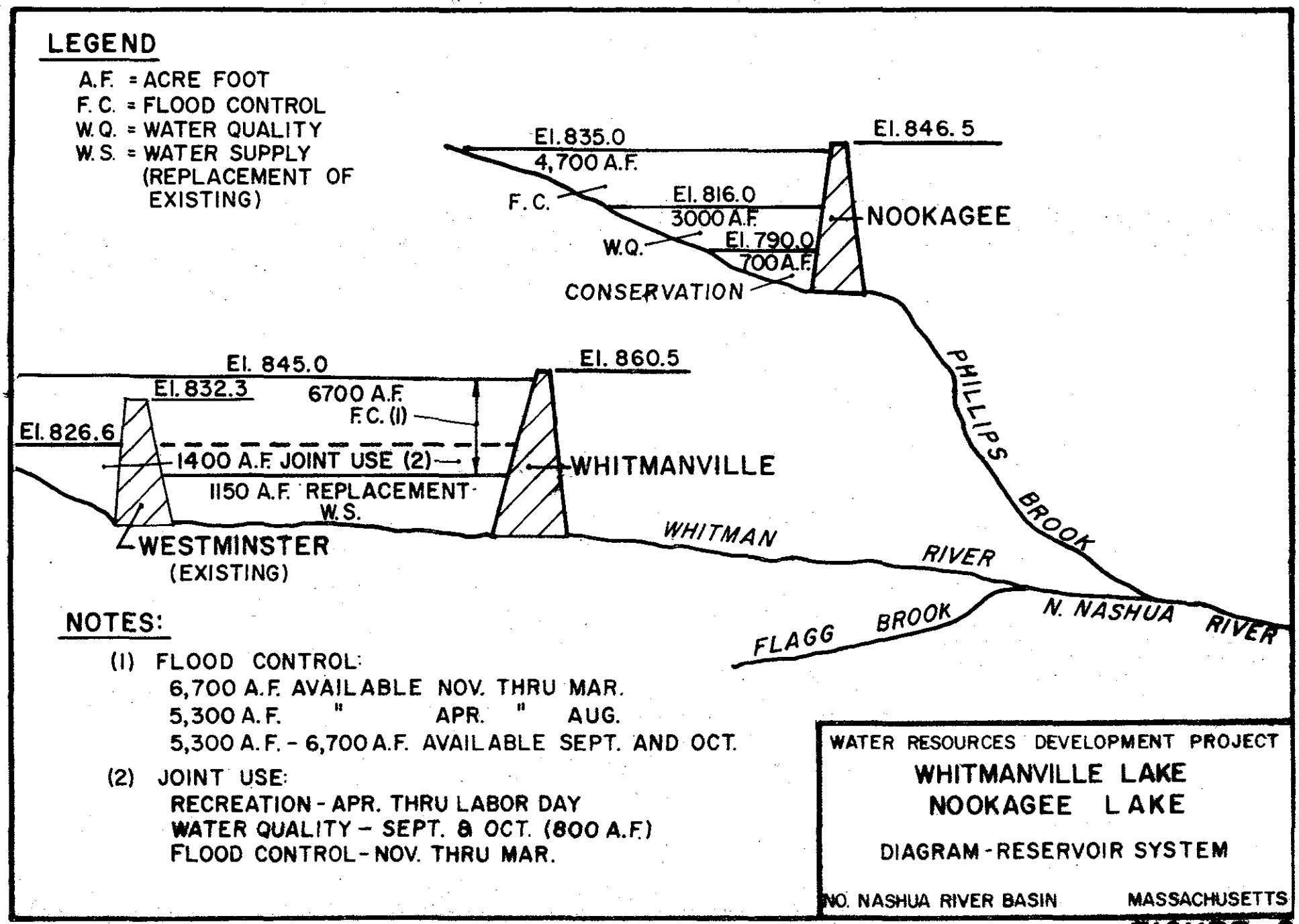
c. Hold and save the United States free from all damages due to water-rights claims resulting from construction and operation of the reservoirs;

d. Exercise to the full extent of their legal capability, control, against removal of water in the basin which will affect the reservoirs, water quality storage and the development of dependable stream regulations; and

e. Exercise, to the full extent of their legal capability, control against removal of stream flow made available by reservoir storage for water quality.

The proposed changes in the projects were submitted on 12 February 1971 to the Office of the Chief of Engineers for review and approval as a report entitled, "Whitmanville Dam and Lake, Whitman River - Nookagee Dam and Lake, Phillips Brook, North Nashua River Basin, Justification for Altering Project Purposes". The report was approved as a basis for further planning by the Office of the Chief of Engineers on 28 May 1971. See Appendix A for contents of the report and letter of approval. Comments by OCE have been incorporated in this design memorandum.

The approved alterations thereby make the projects' purposes as:



NOTES:

(1) FLOOD CONTROL:
6,700 A.F. AVAILABLE NOV. THRU MAR.
5,300 A.F. " APR. " AUG.
5,300 A.F. - 6,700 A.F. AVAILABLE SEPT. AND OCT.

(2) JOINT USE:
RECREATION - APR. THRU LABOR DAY
WATER QUALITY - SEPT. & OCT. (800 A.F.)
FLOOD CONTROL - NOV. THRU MAR.

WATER RESOURCES DEVELOPMENT PROJECT

WHITMANVILLE LAKE
NOOKAGEE LAKE

DIAGRAM - RESERVOIR SYSTEM

NO. NASHUA RIVER BASIN MASSACHUSETTS

FIGURE 2

Whitmanville

Flood Control
Recreation
Industrial water supply
(replacement of existing)
Water Quality

Nookagee

Flood Control
Water Quality
Recreation (limited)

52. Evaluation.

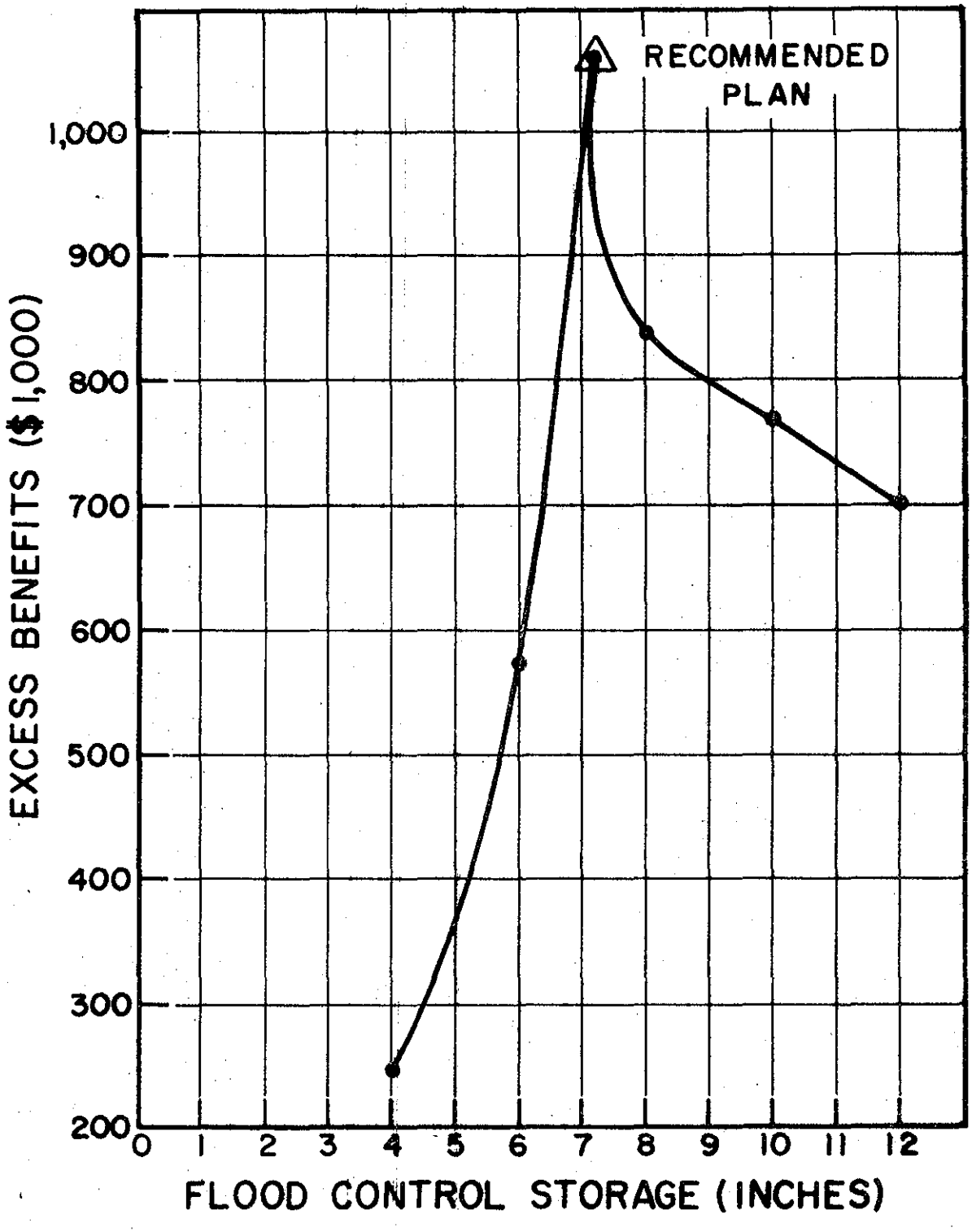
a. Flood Control. - The primary interest for improvement in the basin is to reduce the destructive flood damages in the urban areas of Fitchburg and Leominster, Massachusetts. A study was made of the effect of varying the amount of flood control storage in the Whitmanville Lake reservoir. Studies made considered 4, 6, 7.2, 8, 10 and 12 inches of flood control storage. Each of the six studies included the cost of replacement of the existing water supply system at Westminster Reservoir. Costs, benefits, and excess of benefits were derived for all six plans. The results of the studies are shown graphically in Figure 3 which shows a curve of excess annual benefits for various flood control storages. The curve indicates that the point of maximization of net benefits would be achieved with 7.2 inches of flood control storage. Flood protection above 7.2 inches of storage would require taking of the Oakmont Regional School in South Ashburnham having a current evaluation of $3.5 million. The sharp break in the curve at 7.2 inches of storage reflects the effect of the regional school on the net benefits. Consequently, 7.2 inches of flood control storage was selected in order to provide a high degree of protection in the highly developed and densely populated urban areas of Fitchburg and Leominster.

b. Water Quality Control. - Studies made indicate that downstream water quality could be enhanced by making provisions in the project for low flow releases. The Water Quality Office, formerly the Federal Water Pollution Control Administration, indicated that presently available treatment methods alone cannot control the polluted condition of the stream and even partial provisions for stream flow regulation would result in substantial improvement with attendant benefits within the basin. Using base flows at four contiguous reaches on the North Nashua River in the Fitchburg-Leominster area, the additional fresh water required to maintain the total flow in the river above acceptable dissolved oxygen levels was determined at the Leominster USGS gage and at Arden Mill Dam (See Plate 2-1). At Leominster the maximum augmentation required for any one year was determined to be 2,400 acre-feet, whereas for Arden Mills the augmentation was found to be more critical with a requirement of 3,800 acre-feet. The storage of 3,800 acre-feet (3,000 a.f. at Nookagee and 800 a.f. at Whitmanville) will be adequate to meet the water quality control requirements established at Arden Mill Dam with a 95% dependability. For extremely severe drought conditions such as the critical 1964-66 period (considered as 1 in 100 dry years) the storage would be sufficient for all but 1 month of water quality demands.

c. Recreation. - The project area is accessible to more than 980,000 residents who live within a 40-mile radius of the project. The heavily populated cities of Fitchburg, Leominster and Gardner, Massachusetts are close to the recreation site. Direct access to the project facilities will be from South Ashburnham Road which ties into State Route 101 at the northern end of the reservoir and with State Route 2A on the southern end.

There is a scarcity of publicly-owned, fresh water recreational facilities in the area. Lakes in the basin, in general, are privately owned or controlled and have excluded the public from usage. During meetings with local residents the need for public recreation in the region has been strongly emphasized by the inhabitants.

Preservation of an extensive water surface behind the existing dam will provide a highly attractive source for water-based recreational activities. The recreation pool will stimulate recreational use of project lands, thus increasing their value as recreational assets.



WATER RESOURCES DEVELOPMENT PROJECT

WHITMANVILLE LAKE

EXCESS BENEFIT CURVE

NO. NASHUA RIVER BASIN MASSACHUSETTS

FIGURE 3

Considering the accessibility of the project to the surrounding cities, recreational use will be extensive. The major features of the recreation facilities will be swimming, picnicking, boating, fishing and hiking. The westerly shore area will be reserved as a wildlife sanctuary. Boats with motors will not be permitted on the lake due to possible oil contamination of the water which could affect the quality of paper being produced by the industrial water users. Costs and benefits for recreational development are consistent over a broad range of pool areas.

53. Summary. - Based upon the obligation to replace 1,150 acre-feet of industrial water; the willingness of the Commonwealth of Massachusetts to financially participate in the recreational aspect; and the Water Quality Office's requirements for minimum flows for water quality; the only variable in the project was considered to be the flood control storage. The variation of 4, 6, 7.2, 8, 10 and 12 inches of storage was studied and as previously explained, 7.2 inches, or 6,700 acre-feet of flood control storage is desired to provide the necessary degree of protection for the downstream urban communities. The project is, therefore, recommended for construction containing a total of 7,850 acre-feet of storage consisting of: 1,150 acre-feet of industrial water replacement and 6,700 acre-feet for flood control of which 1,400 acre-feet of seasonal encroachment on the flood control storage will be utilized for recreation. After Labor Day, 800 acre-feet of the 1,400 will be used to meet water quality demands.

P. CORROSION MITIGATION

54. Corrosion Severity. - The sites for the appurtenant structures of the dam are located at a point on the Whitman River which is free from industrial or municipal pollutants thereby the quality of the existing water is generally excellent (Class B). Water Quality data collected at the site indicates that the water is basically neutral as noted in Table 10 of Design Memorandum No. 1, Hydrology (Revised). Sampling has indicated that during certain months of the year traces of chlorides (road salts) do appear. The bedrock on which the structure will be located or the soil to be placed against the structures show no sign of being highly corrosive. Consequently, normal corrosive resisting materials will be selected for the structures and the normal amount of concrete protection will be afforded the reinforcing steel.

Q. ACCESS ROADS

55. General. - The alignment of the haul road from the borrow area to the damsite will be specified on the contract drawings. A tentative alignment of the haul road, which appears to be compatible with the recreational development, is shown on Plate 2-2. Alternate alignments will be evaluated during final design of the project. Consideration will be given to the use of part of the haul road for access to the recreational facilities. Clearing for the road will be kept to a minimum and will be specified. Where the segment of haul road is found suitable as an access road for recreation, upon completion of construction of the dam, the road will be regraded and constructed as a permanent road according to contract plans. Where not used as a permanent access, the haul road will be removed, topsoiled and seeded and left as a trail.

R. CONSTRUCTION MATERIALS

56. General. - The embankment section for the dam will be of the zoned type with an impervious fill zone, random and pervious fill zones, drainage features and rock slope protection. Foundation cutoff will be made to bedrock under the impervious fill section.

57. Impervious Material. - Field investigations to locate a source of material suitable for use in the impervious sections of the embankment indicate that a very extensive deposit of till is available on the slope between Bragg Hill Road and South Ashburnham Road approximately one mile north of the damsite. The till consists generally of gravelly, clayey sand with gravelly and sandy silt phases.

58. Random and Pervious Materials. - Material from required excavations on the abutments will consist of variable, partly modified till composed mainly of semi-pervious, silty, sandy gravels and silty, gravelly sands with numerous cobbles and boulders. In the valley bottom required excavations will encounter stratified materials, mostly pervious sandy gravels and gravelly sands underlain by till composed of silty, gravelly sand and silty, sandy gravel. All these materials will be utilized in appropriate sections of the embankment.

59. Embankment Drainage Materials, Gravel Bedding and Road Gravel. - Very extensive deposits of pervious material consisting of silty, sandy gravels and gravelly sands occur in the valley immediately upstream from the site. These deposits occur mainly below permanent summer pool elevations. No exploration has been done in this area and utilization of these materials is not planned because of ecological considerations and possible damage to the recreational potential of the reservoir. Similar deposits occur in several areas throughout the valley, however, and commercial operations are active at some of these locations. It is currently planned that all processed drainage materials, gravel bedding and road gravels will be furnished by the contractor from off-site sources.

60. Rock Slope Protection and Riprap. - Rock from required excavations consisting mainly of granite-gneiss and pegmatite will be available for rock slope protection and riprap. The granite-gneiss is hard, generally fresh and durable. The pegmatite is also hard but it tends to break down in blasting and handling to produce a large amount of micaceous fines. In addition, all the excavations in rock are relatively shallow and will be largely in rock which is broken by closely-spaced, weathered joints and dirt-filled seams so that considerable fines will be produced and overall bulking will be offset by losses in blasting and handling. If additional rock is required, it can be obtained by quarrying on the uphill side of the spillway approach channel.

61. Concrete Aggregates. In view of the small quantity of concrete required, investigations of sources of aggregate materials has been limited to consideration of established commercial sources within a 25 mile haul distance of the site. Complete data on testing of concrete aggregates is presented in Design Memorandum No. 6, Concrete Materials.

S. PUBLIC USE

62. Site Description. - The location of the Whitmanville Lake project with respect to public use is most fortunate, since it is in a typical New England rural setting characterized by rolling hills, woods, flowing water and sparse population. The area is readily accessible to more than 840,000 Massachusetts residents and 140,000 New Hampshire residents who live within 40 miles of the lake. The heavily populated cities of Fitchburg, Leominster and Gardner, Massachusetts are close to the project site.

The availability of the project lands and water for public use will be a significant asset to the surrounding area. It is important, therefore, that public use development be carefully planned and executed, not only to provide recreational facilities for public use, but more importantly, to protect and preserve the natural amenities on the site. Besides the scenic assets of the area, other assets include a fishery, woodland for hiking and allied sports, a shoreline readily adaptable for swimming and a population of small game and birds. No assets of historical or archaelogical importance have yet been found, but research in that respect will continue in cooperation with local individuals and groups.

63. Planning Concept. - Facilities to be built are as follows:

A boat launching area including a dual boat ramp, a parking area, and improvements to the shoreline.

A picnic area which will include a parking area, picnic tables, fireplaces, a comfort station and a water supply system. Integrated with this area will be paths, trails and a group use playfield.

A bathing beach with the requisite comfort station-change house, a parking area, a water supply system and the necessary roads and walks.

Future development if deemed necessary would consist of expansion of the above facilities.

Site plans for the entire area will be developed to insure that all structures and other facilities are visually and practically compatible with topography and natural cover. Special attention will be given to vistas and scenic views. Landscape planting will be included in project design so that judicious use of plant material will soften architectural lines and enhance the visual impact of the completed project.

Development of recreational facilities will be financed on a cooperative basis with all costs being shared equally by the Federal government and the Commonwealth of Massachusetts in accordance with the Federal Water Project Recreation Act, Public Law 89-72. The total cost of the recreation development is estimated at $320,000.

T. ENVIRONMENTAL QUALITY

64. Architectural and Engineering Treatment. - Architectural design of facilities and structures required for this project will consider the rural environment as the basis for aesthetic criteria. The number and size of structures proposed for the dam operation and recreation facilities are minimal and as designed will not have a significant impact on the natural setting. The facades will be simple, functional statements of use which will provide an attractive appearance commensurate with their location.

65. Landscape Architectural Treatment. - Since landscape architecture is the science and art of correctly using land and water for human use and enjoyment, and since the purposes of Whitmanville Lake are for human use (flood control and water quality) and human enjoyment (recreation and visual amenities), it follows that landscape architecture will be an important element of design effort. The principles of landscape architecture will be applied during project design to insure:

a. Acquisition of land area sufficient for all project needs including those needs related to visual and aesthetic values.

b. Inclusion in final design of complete site plans for the entire project area, showing not only features to be constructed, but also temporary facilities necessary for construction operations.

c. Inclusion of plans for protection and preservation of existing natural assets including vegetation and land forms.

d. Inclusion of plans for use of plant material as needed for landscape planting purposes such as the softening of architectural lines, tying the new work together and to the surrounding landscape, providing visual amenities, screening and for shade. If necessary, a reforestation plan will be developed.

Development features will be designed to blend with existing site characteristics, so that structures, walks, roads, trails, parking areas and other elements are compatible with the natural environment.

The land encompassed by the dam and reservoir area is typical of central New England countryside, characterized by rolling wooded hills, quiet streams, expanses of sky framed by forest growth, and the absence of the noise, confusion and untidiness associated with man-made development. In such an area where man senses nature with its living entities of forest and stream, development must be coordinated with the intangible as well as the tangible site assets in order not to become an intrusion. To the extent possible, the project will be coordinated with the site amenities rather than intruded upon them.

66. Environmental Impact. - A detailed study of the impact of the project on the environment is being pursued as required and will be documented in the environmental statement, which will be submitted separately from this memorandum. The study will evaluate impacts on the terrestrial and aquatic life forms, will analyze any unique or unusual natural sites found in the area of proposed impoundment, will thoroughly consider visual and aesthetic impacts and will evaluate the influence of the project on the area. To assist in the environmental impact study, a consulting firm having the necessary capabilities will be engaged.

U. REAL ESTATE REQUIREMENTS

67. Description. - In accordance with ER 405-2-150, and with clarifying guidelines set out in teletype dated 13 July 1971 from DA (COE) to AIG 7581, Subject: "Real Estate Acquisition", it is proposed to establish a minimum guide taking line 300 feet horizontally from the conservation pool, elevation 826.6 feet above m. s. l. and/or the "Guide Taking Line", elevation 850 feet above m. s. l., whichever is greater. It is proposed to acquire in fee, lands to the east of the project located between the Guide Taking Line and the right of way for the proposed relocated South Ashburnham Road, as these areas are required for recreation development. The reservoir area will extend from proposed dam site, in the northwesterly direction along the Whitman River to include the existing Westminster Reservoir

to intersection of Platts Road and Westminster Street in the southwesterly end of the town of Ashburnham. The estimated project area is 638 acres, including the areas of the dam site, borrow area and construction area.

The reservoir will be contained in a valley framed by gradual to steep sloping wooded hillsides. A large portion of the project area is owned by the Weyerhaeuser Company (Nashua River Reservoir Company), a privately-owned paper products manufacturer.

The area on the westerly side of the valley, southerly of the new Oakmont Regional School Athletic Field is essentially undeveloped gradual to steep sloping wooded hillsides.

The area to the easterly side of the valley, southerly of Westminster Street and Platts Road, is also essentially underdeveloped gradual to steep sloping wooded hillsides. This area is the sparsely improved area of the valley, containing developed and potentially developable residential lands, a few farms of the small marginal type and rural residences.

The northerly section of the project is within the town limits of Ashburnham. The area is improved primarily with village type residential properties and a rather large industrial woodworking concern. The unimproved portion of this area comprises mostly low meadow lands. It is recommended that this area of the project be acquired in fee. This area contains about 64 acres.

The improvements located within the proposed project consist of 27 homes classified as both village type residences and rural residential units with small acreages, an industrial woodworking plant, the Westminster dam and reservoir, and a portion of the athletic field of the Oakmont Regional High School.

68. Utilities. - Electric power and telephone facilities are available to all properties within the proposed project area. Sewage facilities are provided by individual owners through the use of septic tanks or cesspool systems. A town water system is available to the properties situated within South Ashburnham. Water is provided by individual owners by wells to all properties situated in Westminster and within the project area.

69. Zoning. - The town of Westminster, presently, has no zoning regulations. Most of the land situated in South Ashburnham, that is within the project area, is located in an "Agricultural-Residential" district. A small area around the industrial plant, situated along Westminster Street and Williams Road, is zoned for Commercial-Industrial purposes.

Area requirements within an Agricultural-Residential zone include a 25,000 square foot lot with a hundred foot frontage. There are no area requirements specified for Commercial Industrial Zones.

70. Highest and Best Use. - The highest and best uses of the land within the project area are considered to be the present uses or as available for development.

71. Mineral Deposits. - Field inspections disclosed no evidence of commercial mining of gravel nor the deposits of any minerals within the project area.

72. Crops.

a. Agricultural. - There are a few small areas of meadow land situated within the project area, however, none of these areas are currently being used for commercial crop purposes.

b. Timber. - A large portion of the land located within the project area is classified as wooded, and there are a few small stands of merchantable species. However, the quality and quantity are considered inadequate to require inclusion of any special allowances for merchantable timber. The value of any timber within the proposed reservoir area is reflected in the land value.

73. Water Rights. - The Weyerhaeuser Company has valuable water rights along the Whitman River. The dam and reservoir, which are situated within the project area, provide a source of industrial water to their downstream mills. Present project plans include the replacement of this water supply system within the proposed project, and therefore, its value is not included in this report.

74. Borrow Requirements. - The borrow area is located along the westerly side of Bragg Hill Road about one mile north of the intersection of South Ashburnham Road. It contains about 71 acres of both cleared and wooded land.

75. Relocations. - A portion of South Ashburnham Road and North Common Road will require relocation. Westminster Street will require raising in-place. There are approximately 27 acres of land in the road alignment. All community water lines in South Ashburnham will be relocated, as required, and electric power lines and telephone facilities will be relocated within the new road right of way.

76. Municipally-owned Facilities. - Section III of the Act of Congress, approved 3 July 1958 (Public Law 85-500) authorizes the protection, alteration, reconstruction, relocation or replacement of municipally-owned facilities.

A portion of the land of the Oakmont Regional High School, located on the Ashburnham-Westminster Town Line, will fall within the "Guide Taking Line" elevation 850 feet above m. s. l. It is conservative to estimate a value of $3,500,000 as the replacement cost to this educational complex, however, for purposes of this report the only developed land area that is affected by the projects' taking line is a portion of the school's athletic field. It consists of about 25% of the girl's athletic area and the entire baseball field. In addition to the developed land areas, the taking will also include an embankment and the school's main access road. Current plans indicate that the access road will be raised to allow all weather access. The government taking will in no way adversely affect the school's sewage system.

It is recommended that the required area of 15 acres from this ownership be acquired under a flowage easement to help reduce the severance damages to this educational complex.

77. Acquisition Costs. - Experience of this office in acquiring similar properties in other civil works projects in the area indicates that acquisition cost will average approximately $1,200 per tract. These costs include mapping, surveys, legal descriptions, title evidence, appraisals, negotiations, closings, and administrative costs for condemnation. The number of ownerships within the town of Westminster were computed from the local assessor's maps, and are, therefore, considered reasonably accurate. There are no property maps or assessor's maps available in Ashburnham. The number of tracts affected by the project in this town were estimated by counting the number of improvements, and also through discussions with local officials. Based on this preliminary survey, the number of ownerships and acquisition costs are estimated as follows:

45 Ownerships @ $1,200	=	$54,000

78. Reservoir Boundary Surveys and Markings. - Existing regulations require the marking of all reservoir boundary lines. Survey costs for making property boundary lines are estimated at $2,000 per mile. The perimeter distance is estimated to be 9.09 miles, therefore:

9.09 Miles @ $2,000	=	$18,180
Rounded To		$18,200

79. Resettlement Costs. - Public Law 91-646, the Uniform Relocation Assistance and Real Property Act of 1970, provides a uniform and equitable treatment of persons displaced from their homes, businesses, and farms by Federal and Federally assisted programs. In accordance with this law an estimate of $456,000 is included in this report to cover the implementation of this Act.

80. Severance Damages. - Severance damages usually occur when partial takings are acquired. Severance damage is the damage to the part not taken which arises by reason of the taking and/or the construction of the improvement. It is planned to follow a sound real estate acquisition program so that damages of this nature will be minimized. The total severance damage for this project is estimated to be $30,000.

81. Contingencies. - A contingency allowance of 15% is used on all costs with the exception of resettlement costs to provide for possible adjustments or refinements of the taking lines for unknown ownerships which may develop, for adverse condemnation awards, and to allow for actual, practical and realistic negotiations pursuant to the recently enacted Uniform Relocation Assistance and Real Property Act of 1970, Public Law 91-646.

82. Evaluation. - A search of the records was made in both the towns of Ashburnham and Westminster to obtain comparable sales data. In addition, real estate brokers, local officials, and knowledgeable persons were interviewed to secure data and value estimates. The property evaluation is based on a knowledge of the general real estate market in this area which was obtained from survey and by analysis. It is predicated, however, on only an exterior inspection of the affected properties and a preliminary market data survey. The land values used in this estimate are average unit values which reflect for both large and small tracts of land with differing physical characteristics.

The values assigned to developed lots include all land improvements. Potentially developable residential land consists of land fronting on the public roads with a potential for development in the foreseeable future. The value assigned is an average unit value which reflects for lots ranging from poor to good. The land classified as wooded and cleared consists of poor land fronting on roads and rear lands.

The estimated real estate market values and total real estate costs are as follows:

WHITMANVILLE LAKE

COST SUMMARY

Improvements

27	Dwellings	$354,200	
1	Woodworking Shop	92,000	
28	Total Value of Improvements		$446,200

Land

27 Acres	Developed Residential Homesites @ $2,500 Each	$ 67,500	
3 Acres	Developed Industrial @ $5,000 Each	15,000	
51 Acres	Potentially Developable Residential Sites @ $2,000 Each	102,000	
408 Acres	Wooded and Cleared @ $200 P/A	81,600	
15 Acres	School Land @ $1,750	26,250	
117 Acres	Water	0	
17 Acres	Roads	0	
638 Acres	Total Value of Land		$292,350
Total Value of Land and Improvements			738,550
Acquisition Costs			54,000
Reservoir Boundary, Survey and Markings			18,200
Severance Damages			30,000
Contingencies (15% of $840,750)			126,112
Resettlement Cost			456,000
	Total Real Estate Cost		$1,422,862
	Rounded To		$1,400,000

V. RELOCATIONS

83. Relocations. -

a. Roads. - Portions of the following roads with average daily traffic volumes of 20 - 1340 vehicles are located within the reservoir area. Actions to be taken for the portions of the roads involved are indicated below:

Road	Action
South Ashburnham Road	Relocated
Westminster Street	Regraded & Relocated
School Access Road	Regraded
Platts Road	Regraded
Needham Road	Regraded
Barrel Road	Regraded
Bragg Hill Road	Relocated
North Common Road	Relocated

A total of approximately 3.0 miles of existing roads within the reservoir will require relocation, raising or improvement and 2.5 miles will be abandoned. South Ashburnham Road is the most heavily traveled highway in the reservoir area with an average daily traffic volume of 1,340 vehicles and is the only improved highway connecting Whitmanville with South Ashburnham.

b. Utilities. - Utilities in the reservoir area requiring relocation consist of electrical distribution, telephone lines and a water line.

84. Method of Accomplishment. -

a. Roads. - The changes in the road system, as affected by the reservoir, will be accomplished by the Government to conform with the geometric highway design standards of Worcester County and the Commonwealth of Massachusetts for existing traffic volumes. Construction will be by a separate relocation contract. The estimated cost of raising and relocating all roads is $1,080,000. All proposed road relocations and detailed cost estimates will be described in Design Memorandum No. 4 - Relocations.

(3) When WQO minimum flow requirements are being met at Arden Mill Dam and the Leominster USGS gage. An accounting plan to maintain a record of the reservoir storage will be developed.

In the interim period prior to the completion of the Nookagee Project, the recreation pool at Whitmanville will still be maintained until Labor Day. Water quality releases, if necessary, will then be made after Labor Day.

97. Recording Equipment and Gages. - A pool state recorder will provide a continuous record of the water level upstream of Whitmanville Lake, and a tile gage will also be used for reading pool levels and for calibrating the recorder. A tailwater recording gage will measure both high and low flow reservoir releases. In addition a tile gage will be provided at Westminster Dam for reading Westminster Lake pool levels.

A recording gage, established in the vicinity of Arden Mill Dam will monitor riverflow and will be used as the primary index station for flood control or water quality releases from Whitmanville Lake. Other gages, either recording or staff, will be installed, as needed, at important downstream index stations.

Permanent water quality monitoring equipment will be installed at Whitmanville Dam and also in the vicinity of Arden Mill Dam in order to measure various water quality parameters. These parameters will include dissolved oxygen, water temperature, PH, conductivity or other chemical, physical and bacteriological parameters as may be deemed necessary. Evaporation pans will be located at the project to measure relative rates of evaporation.

98. Communications. - In order to assure continuous contact between the operating personnel at the dam and the Division Office in Waltham, Massachusetts, telephone and radio equipment will be installed at the utility building and remoted to the operating room. Data from the Leominster gaging station and from the water quality gage on the North Nashua River near Arden Mill Dam will be directly transmitted to the Reservoir Control Center.

W. COST ESTIMATES

85. First Costs. - Unit prices used in estimated construction and relocation costs are based on average bid prices for similar work in the same general region, adjusted to the 1971 price level. Valuations of real estate are based on recent appraisals of properties at the site and includes the additional costs for resettlement and acquisition as required under the recently enacted Public Law 91-646. All construction costs include an allowance of 15 percent for contingencies. The total first cost of the project is estimated at $7,750,000. A summary of the cost of the various features of the work is given in Table 1 and a detailed breakdown of quantities and unit prices is included in Appendix D.

TABLE 1
SUMMARY OF PROJECT COSTS
(June 1971 Price Level)

Project Features	Estimated Cost
Lands and Damages	$1,400,000
Relocations	1,130,000
Reservoir	200,000
Dam and Appurtenant Structures	3,400,000
Roads	35,000
Recreation Facilities	260,000
Buildings, Grounds & Utilities	110,000
Permanent Operating Equipment	60,000
Engineering and Design	685,000
Supervision and Administration	470,000
Total Estimated Project First Cost	$7,750,000

86. Comparison of Estimates. - The current cost estimate of $7,750,000, shown in Table 1 reflects an increase of $1,500,000 since the last reported estimate in Appendix A which amounted to $6,250,000. The following outlines and explains the changes:

TABLE 2

Project Feature	Authorized 1964	Previous 1970	Current 1971	Change 1970-1971
Lands and Damages	$ 515,000	$ 940,000	$1,400,000	$ 460,000
Relocations	625,000	830,000	1,130,000	300,000
Reservoir	62,000	80,000	200,000	120,000
Dam	1,922,000	2,900,000	3,400,000	500,000
Roads	15,000	20,000	35,000	15,000
Recreation Facilities	0	300,000	260,000	-40,000
Bldgs., Grounds & Util.	0	70,000	110,000	40,000
Perm. Operating Equip.	0	40,000	60,000	20,000
Engineering & Design	446,000	640,000	685,000	45,000
Supervision & Adminis.	255,000	430,000	470,000	40,000
Total Cost	$3,840,000	$6,250,000	$7,750,000	$1,500,000

a. Escalation from 1964 to 1970. - The cost estimate of 1970 was based primarily on normal expected escalation of the 1964 price levels.

b. Changes from 1970 to 1971. -

(1) The Uniform Relocation Assistance Policy Act of 1970, Public Law 91-646, which authorized additional costs for resettlement and acquisition of real estate, increased the cost of lands for the reservoir and for the road relocations by approximately $521,000 of which $456,000 was attributed to reservoir lands and $65,000 for relocation lands.

(2) The increase in cost of $120,000 for the item "Reservoir" is due primarily to the need for grubbing and stripping 70 acres of land in the reservoir which would affect the quality of the industrial water. The concern for possible degradation of the industrial water quality has been expressed on several occasions by the paper industry. Their concern was underscored by the letter from the Weyerhaeuser Company dated 2 August 1971, Exhibit C.

(3) The major increase in the cost of the dam is attributed to the flattening of the upstream slopes from 1 on 3 to 1 on 4. Since the impervious material was found to possess low shear strengths

the embankment slopes had to be flattened to insure stability. This resulted in an increase in needed quantity of impervious material of 80,000 c.y. with a resulting increase in price of $120,000. An increase in the unit price of the impervious material from $1.00/c.y. to $1.40/c.y., resulted in a further cost escalation of $152,000.

(4) Concern for the environmental impact of the project, particularly during construction, has indirectly influenced the cost. Restrictions on the contractor's operations in the borrow area, the selection of the haul road, sequential clearing and stripping, disposal of trees, erosion control, etc., have decidedly influenced construction costs.

(5) A cost escalation since the previous estimate of 9% due to higher costs of labor and materials, is accountable for part of the increase in the total cost of the project.

X. SCHEDULE FOR DESIGN AND CONSTRUCTION

87. Design. - Preparation of plans and specifications for the relocation of South Ashburnham Road will be essentially completed in December 1971. Preparation of plans and specifications for the dam and appurtenant structures will be completed in September 1973 - subject to availability of construction funds.

88. Construction. -

a. Relocations. - South Ashburnham Road passes through the dam site, therefore, its relocations must be initiated early in the construction program in order to clear the work area for the construction of the dam. Construction of the relocated road will be initiated in the early spring and completed in the fall of the following year (2nd half Construction Fiscal Year One thru 1st half of Construction Fiscal Year Three). The work for the relocated highway will be accomplished under a contract administered by the Corps of Engineers. Construction of the relocation of electric distribution, telephone, and water lines will be accomplished under separate contracts to be negotiated with the respective utility companies in Fiscal Year One.

b. Dam and Appurtenant Structures. - Construction of the dam, outlet works, spillway and clearing of the reservoir

will be accomplished under a single continuing contract to be awarded in Late-Construction Fiscal Year Two when the highway relocation has progressed to an advanced stage of completion. An estimated construction schedule follows:

(1) First Season of Dam Construction. - During the remainder of the construction season (remainder Fiscal Year Two and 1st half of Construction Fiscal Year Three), the contractor will mobilize and initiate and complete the clearing and grubbing of the site of the structures and borrow area and initiate construction of the outlet works.

(2) Second Season of Dam Construction (2nd half Fiscal Year Three and 1st half Fiscal Year Four Construction Seasons). - The contractor will continue the construction of the outlet works and by 1 June must complete the inlet and outlet channel, the intake tower to an elevation above the permanent cofferdam, the conduit, the stilling basin and the lower portion of the spillway discharge channel. He will construct by mid-June temporary cofferdams upstream and downstream of the damsite and divert the Whitman River through the outlet works. After the diversion has been completed, the contractor will strip the damsite, excavate the foundation cut-off trench and the drainage trench, initiate foundation grouting and complete the grouting and backfill of the segment of cut-off trench between Sta. 7+50 and Sta. 14+00 by mid-November. The contractor will also initiate the excavation of the spillway channel and begin placement of the rock protection on the downstream dam embankment.

(3) Third Season of Dam Construction (2nd half Fiscal Year Four and 1st half Fiscal Year Five Construction Seasons). After the snow has melted and the danger of floods has passed, the contractor will first construct the permanent cofferdam (which will be part of the main dam) and complete by 1 November the dam embankment, the remainder of the outlet works (including the service bridge), the spillway and the access road, as well as initiate construction of buildings. After 1 November, the reservoir clearing and stripping will begin.

(4) Fourth Season of Dam Construction (2nd half Fiscal Year Five Construction Season). - The clearing and stripping of the reservoir will be completed as will be the buildings. All work is expected to be completed by 1 June (Fiscal Year Five).

89. Funds Required. - Funds will be required by fiscal years approximately as follows:

Construction Fiscal Year	Amounts Required
1	$ 900,000
2	1,600,000
3	1,600,000
4	1,400,000
5	1,680,000
Sub-Total	$ 7,180,000
Allotted thru Fiscal Year 1972	570,000
TOTAL PROJECT ESTIMATE	$ 7,750,000

Y. OPERATION AND MAINTENANCE

90. General. - The Whitmanville Lake project will be operated and maintained by the Federal government, and the Commonwealth of Massachusetts under the supervision of the Division Engineer, Corps of Engineers, Waltham, Massachusetts.

91. Operations. - The reservoir will be regulated for industrial water, flood control and water quality control by the Corps of Engineers and the recreational facilities will be operated by the Massachusetts Department of Natural Resources. Regulation of the industrial water, although under the control of the Corps, will be made at the wishes of the industrial water users (NRRC). There will be no restrictions on usage or rate of releases on the industrial water allotment. Operational details are outlined in Section Z, RESERVOIR REGULATION, of this report.

92. Maintenance. - Periodic inspection will be made of the Whitmanville and Westminster dams and appurtenant structures and equipment. The dams and appurtenant structures will be maintained and operated by a Corps of Engineers' staff. Maintenance will be based on regular detailed inspection of the entire works, including all operations necessary to preserve the structures.

93. Major Replacements. - Items deemed to have a usable life less than that of the project will be replaced when necessary. Most items such as flood control gates, gate valves, heating and ventilation systems, instrumentation equipment and part of the recreational facilities are considered to be replaced every twenty-five years. The Commonwealth of Massachusetts will be responsible for the replacement of recreational facilities.

94. Annual Costs. - The estimated annual cost of operation and maintenance is $62,000. Estimated annual cost of major replacement is $6,000. Operation and maintenance and replacement costs currently allocated to the Commonwealth of Massachusetts for the recreational facilities amounts to $18,000 annually.

Z. RESERVOIR REGULATION

95. General. - Flood control and water quality discharges from the project will be regulated by the Corps and will be coordinated with releases from Nookagee Lake, which is also under design. Releases of the industrial water supply will be made by the Corps as requested by the Nashua River Reservoir Company (NRRC). The allocation of the total storage of 7,850 acre-feet for Whitmanville is summarized in paragraph 51 and in Figure 2 of this memorandum.

96. Regulation Procedures. -

a. Flood Control. - Whitmanville Lake discharges will be regulated primarily to prevent or reduce flood flows on the North Nashua River in Fitchburg, Leominster and Lancaster and secondarily for downstream communities on the Nashua and Merrimack Rivers. The Reservoir Control Center, a branch of the Engineering Division, will establish detailed regulations of operations during the construction of the project.

b. Industrial Water Supply. - Westminster Reservoir is used by NRRC for industrial water supply and contains 1,150 acre-feet of water at top of flashboard (elevation 826.6). During flood periods, water stored in Whitmanville Lake may overtop the Westminster dam which is at elevation 832.3 feet, m.s.l.

The draft on Whitmanville Lake during the recreation season will be a function of the paper industry's demand upon its water supply allotment. Initial demands for industrial water supply will be met by drawing down both Whitmanville Lake and Westminster recreation pool 1.5 feet (826.6 to 825.1), which is equivalent to 250 acre-feet total (behind both dams). The recreation pool will then be maintained at this elevation until Labor Day, and further drafts will be made from the intervening storage between the existing Westminster Dam and the new Whitmanville Dam. If operated in this fashion, the maximum head differential on the existing dam during the recreation season would be approximately 7 feet (total withdrawal = 650 acre-feet) for the average year and about 13 feet (total withdrawal = 900 acre-feet) for drought years. Foundation studies concerning the safety of Westminster Dam indicate that the head differential between the two pool levels should not exceed 13 feet. The drawdown rate of the lower pool, up to a net differential of 13 feet, is unrestricted and has little effect on the stability of Westminster Dam.

c. Water Quality-Recreation. - Toward the end of the spring snowmelt season in March or April, a joint recreation-water quality pool will be established by storing 1,400 acre-feet of water within the flood control zone. However, in order to stabilize the summer recreation pool to the fullest extent possible, it is contemplated that all necessary water quality releases for the period June to Labor Day would be made from the 3,000 acre-feet of water quality storage at Nookagee Lake. After Labor Day the releases from Nookagee would then be stopped, and water quality releases from Whitmanville Lake will commence. Also after Labor Day the two pool levels would be equalized by opening both gates in the Westminster Dam. Operationally, Whitmanville Lake will be drawn to at least elevation 817.5 by 1 November making 6,700 acre-feet (7.2 inches) available for flood control storage. It is anticipated that the refill of storages in the basin will be coordinated between NRRC and the Corps, but in general the storage of spring runoff for the joint use pool at Whitmanville will occur:

(1) After the 1,150 acre-foot industrial water supply storage is filled;

(2) When minimum process water requirements at downstream plants are being met; and

(3) When WQO minimum flow requirements are being met at Arden Mill Dam and the Leominster USGS gage. An accounting plan to maintain a record of the reservoir storage will be developed.

In the interim period prior to the completion of the Nookagee Project, the recreation pool at Whitmanville will still be maintained until Labor Day. Water quality releases, if necessary, will then be made after Labor Day.

97. Recording Equipment and Gages. - A pool state recorder will provide a continuous record of the water level upstream of Whitmanville Lake, and a tile gage will also be used for reading pool levels and for calibrating the recorder. A tailwater recording gage will measure both high and low flow reservoir releases. In addition a tile gage will be provided at Westminster Dam for reading Westminster Lake pool levels.

A recording gage, established in the vicinity of Arden Mill Dam will monitor riverflow and will be used as the primary index station for flood control or water quality releases from Whitmanville Lake. Other gages, either recording or staff, will be installed, as needed, at important downstream index stations.

Permanent water quality monitoring equipment will be installed at Whitmanville Dam and also in the vicinity of Arden Mill Dam in order to measure various water quality parameters. These parameters will include dissolved oxygen, water temperature, PH, conductivity or other chemical, physical and bacteriological parameters as may be deemed necessary. Evaporation pans will be located at the project to measure relative rates of evaporation.

98. Communications. - In order to assure continuous contact between the operating personnel at the dam and the Division Office in Waltham, Massachusetts, telephone and radio equipment will be installed at the utility building and remoted to the operating room. Data from the Leominster gaging station and from the water quality gage on the North Nashua River near Arden Mill Dam will be directly transmitted to the Reservoir Control Center.

AA. HEALTH CONTROL

99. Existing Pollution Health Hazard. - Serious pollution exists in the North Nashua River from the outfall of the uppermost paper company in Fitchburg to its confluence with the Nashua River at Lancaster. The industrial and domestic pollution not only inhibits the potential uses of the water but is a serious health hazard to the inhabitants of the basin. In December 1968, the Northeast Region of the Federal Water Pollution Control Administration issued a five part report on the pollution of the Merrimack River and certain tributaries and in the course of summarizing stated that the "excessive bacterial pollution presents a health hazard to all who come in contact with the water". Conversely, the Whitman River is of high quality and nearly free of pollutants. Two areas where pollutants are discharged into tributaries of Whitmanville Lake have been detected in the preimpoundment water quality testing program. The Department of Natural Resources of the Commonwealth of Massachusetts has been made aware of the condition and steps are being taken to eliminate the hazard. The Department has given assurances that the condition will be corrected prior to construction of the project.

100. Vector Problem. - Based upon conversations with the Regional Office of the U. S. Public Health Service and the Environmental Health Division of the Massachusetts Department of Public Health, there are no published reports on the vector hazards of the Merrimack River Basin. A summary of the information available concludes that the vector problem can be divided into two groups: Vector-Borne Diseases and Vector-Annoyance Problems.

a. Vector-Borne Diseases. - The two vector-borne diseases of potential importance in the Merrimack River Basin include the viral encephalitis and Rocky Mountain spotted fever. The "Eastern" type of mosquito-borne encephalitis does appear in Massachusetts and during the period 1938-1968, 50 cases occurred in Eastern Massachusetts. Although cases of Rocky Mountain spotted fever (transmitted by the American dog tick) have been reported on Cape Cod, no occurrence of this disease has been reported from the Nashua River Basin.

b. Vector-Annoyance Problems. - The vector annoyance

problems, although not a serious public health problem, can cause much annoyance and discomfort. Within the Nashua River Basin the common annoyances include mosquitos, black flies, the deer and horse flies.

c. Control. - To minimize the vector problem for the Whitmanville Lake project, consultation with the U. S. Public Health Service and the Commonwealth of Massachusetts will be pursued and specific recommendations will be requested.

BB. POLLUTION CONTROL

101. Process Water. - Water from the existing Westminster Reservoir is used as process water in the manufacture of paper, consequently, the water supply must be kept free of pollutants. To achieve the pollution control necessary, control measures will be included in the design of the project. Possible sources of pollution and their control are discussed below.

102. Possible Sources of Pollution. - Water, air and noise pollution are possible from the following sources:

a. Soil erosion

b. Dust

c. Clearing and stripping

d. Borrow operations

e. Spoil from batch plant or concrete placing

f. Concrete curing water (Spillway, etc.)

g. Operation of motorized equipment

h. Oil and fuel spillage

i. Contractor storage and equipment maintenance areas

j. Personnel sanitation facilities

103. Pollution Control Measures. - Measures to be employed to minimize pollution include:

a. Soil Erosion. - Erosion of soil by water is a recognized problem. The disadvantages of uncontrolled water erosion include water pollution by water borne soil material, destruction of land surfaces and vegetation, and unfavorable working conditions. It is foreseen that precautions must be taken during dam construction to avoid unnecessary destruction of stabilizing vegetation, control surface runoff, and provide settling basins to remove silt from water before it is discharged into the stream.

b. Dust. - Since dust can become a pollution problem, especially in dry weather, a program making use of water and dust palliatives will be enforced on the project.

c. Clearing and Stripping. - Clearing on the project will be kept to the minimum necessary. Burning of cleared material will not be allowed. All trees will be cut into sawlogs and cordwood, with smaller material processed by woodchippers. The best possible means of disposing of the material will be studied during design.

To avoid organic stain in the water, which would hinder industrial processing, requires stripping of organic surface soil from the reservoir area. The problem of preventing surface erosion during stripping operations and while the reservoir is being filled has been considered. One solution is to strip in increments defined by two contour lines. When the area increments is stripped, the reservoir water level would be raised to cover it. In this manner, no large area would be subject to surface erosion. This and other methods will be studied during design.

d. Borrow Operations. - Pollution by water borne silt is always a problem in borrow operations. Several methods are under consideration to minimize the problem A technique will be studied and resolved during design to control surface water runoff. Water will be collected, channeled to settling basins where silt can be removed at zero or low velocities, and the water discharged to the stream.

To avoid exposure of excavated earth surfaces to water erosion

for longer periods than necessary, a sequential borrow operation will be planned. By this method, certain limited areas will be cleared, stripped, excavated, graded and revegetated in a series pattern. Thus, the disadvantages of waiting until all borrow operations are complete before stabilization of earth surfaces will be avoided, and both excessive water erosion and unnecessary dust pollution avoided.

e. Concrete Spillage. - Since some spillage of concrete can be expected from concrete placement operations, it is recognized that a method of containing such material will be necessary in order to prevent them from entering the river. Probably a system of small dikes and a regular cleanup operation will be necessary.

f. Concrete Curing Water. - Disposal of water used in concrete curing is a recognized problem, and since it can carry materials in suspension which could adversely affect water quality in the Whitman River, a method of controlling it must be worked out in final design.

g. Operation of Motorized Equipment. - Pollution by noise and exhaust emissions is to be expected from operation of equipment. In order to minimize such pollution, a continuing program will be in effect during construction to insure that all engines are properly tuned, that effective mufflers are installed in all equipment, and that correct grades of fuel are used in the engines.

h. Oil and Fuel Spillage. - All necessary precautions will be taken to insure that oil and fuel are not disposed of carelessly, and to insure that the river and/or ground is not polluted by these agents. A strict policy will be enforced requiring that all major equipment maintenance be performed in a predetermined location; that all used oils be placed in containers for proper disposal; and that fuel and oil spillage on the ground be kept to a minimum.

i. Contractor Storage and Equipment Maintenance Areas. - The locations of these areas will be designated by the Government. Grading and drainage will be controlled to prevent surface runoff from carrying pollutants and debris into the river. A policy of dust control will be enforced.

j. Personnel Sanitation Facilities. - Strict sanitation measures will be enforced. The contractor will be required to construct facilities for sanitation and for proper disposal of sewage. As needed, portable pumpout type facilities will be required on the project site.

k. Downstream Stilling Basin. - During design, it will be necessary to evaluate the effectiveness of pollution control measures related to water quality. If it is found that there is a significant possibility that there may be pollutants escaping the control measures described above, consideration will be given to the necessity for construction of a stilling basin downstream of the construction area to trap such escaping pollutants.

CC. BENEFITS

104. General. - The North Nashua River Basin drains the north-central part of Worcester County, the largest county in Massachusetts. Representing slightly less than 10 percent of Worcester County in area, the basin includes the Fitchburg-Leominster SMSA (Standard Metropolitian Statistical Area)-one of three economic nodes which dominate an otherwise almost rural county. The other nodes are the Worcester SMSA and the Webster-Dudley-Southbridge area in the southern end of the county. The Fitchburg-Leominster SMSA lies entirely in the basin.

a. Economy. - Manufacturing is the largest single employer in the basin and the Fitchburg-Leominster area is not only a major manufacturing center, but is also the wholesale and retail trade center for northern Worcester County, adjacent portions of Middlesex County and a part of southern New Hampshire. With 150,000 people living within 15 miles of the center of the SMSA, and having a reasonably good road network, the area has developed into a regional market-place surpassed only by the Worcester SMSA in size and sales volume.

b. Population. - The basin had a population of 98,860 in the 1970 Census. In the decade 1960-1970 population grew 9.9%

compared with 9.4% for the state and 8.7% for Worcester County as a whole. Its gross density of 748.9 people per square mile is slightly higher than that of the state as a whole (715.6) and 79% higher (418) than Worcester County.

105. Flood Control Benefits. -

a. Flood Loss Potential. - Over 2800 acres of land lying along both banks of the North Nashua River and its tributaries are subject to flooding. In its lower reaches the flood plain is largely un-used, but above Mechanic Street bridge in Leominster it is increasingly built over as one travels upstream. Above the Fitchburg-Leominster City line the only portion of the river banks not developed is that occupied by the Fitchburg Airport. Much of Fitchburg's industrial plant and a portion of the commercial center of the city are in the flood plain.

A recurrence of the flood of March 1936, the record flood in the basin, would cause losses estimated at over $35 million under 1971 conditions. Much of the loss would be to industrial properties but commercial and public interests including the airport and the Leominster sewage treatment plant would also be involved.

Annual losses in the basin amount to $1,570,000 under current conditions.

b. Trends of Development. - As noted above, the population of the basin has grown at a rate exceeding that of the State and Worcester County over the past decade. Field reconnaissance indicates that the loss potential in the flood plain has grown at an even faster pace since 1962 as new development has taken place in Leominster. Historic trends in flood losses in New England indicate an increase in the loss potential in developed or partly developed areas with the passage of time. This is especially true with industrial properties where the need to stay competitive means increasingly sophisticated plant but it is also true for commercial properties. Part of the increase

in flood loss potential is due to additions to existing properties, part is due to increased values of contents in structures (such as color television sets replacing black and white sets) and part is due to new construction. All these items are related to the real wealth of an area. Wealth, expressed as personal income, has been projected to increase approximately 6.5 times, measured in constant 1958 dollars, over the next 50 years for the water resources area of the basin. Flood losses are projected to increase at a rate which is 25% of the increase in personal income. Discounted at 5 3/8% the average annual equivalent value of the growth amounts to 0.576. Annual losses and benefits were adjusted by this factor to reflect the expected growth. Total estimated annual losses amount to $2,474,000 consisting of $1,570,000 to present development and $904,000 average annual equivalent losses due to growth.

c. Annual Flood Damage Prevention Benefits. - Annual flood damage prevention benefits were measured at the difference between annual losses in the basin after the restoration of the North Nashua River channel in Fitchburg and annual losses remaining after the operation of a system of three reservoirs, Nookagee, Whitmanville and Phillips Brook with each reservoir receiving an equitable share of the benefits. Benefits to Whitmanville in the system amount to $1,338,000 consisting of $858,000 to present development and $480,000 average annual equivalent benefits due to future growth. If Whitmanville is considered as acting alone the benefit would be $1,566,000 and as last added, the most stringent economic test, the benefit would be $1,224,000.

106. Water Quality Control Benefits. - Both low flow augmentation and adequate treatment of wastes at their source are essential to meet water quality objectives in the North Nashua River. Benefits from the resulting water quality will be widespread and will include improved public health, more attractive communities, enhanced real estate values, a better aquatic environment, attraction of new industries, better recreational opportunities, and an upgrading of the general economy of the region.

The most feasible alternative method of achieving quality control in the North Nashua River is a single purpose dam and reservoir at the Nookagee project site which would provide water storage for streamflow regulation. The cost of a single-purpose water quality control dam and reservoir affords a measure of the minimum value of the benefits to be derived from low releases.

For the entire North Nashua Reservoir system the total water quality benefits amount to $552,000 have been equated to the annual cost of a single purpose dam at the Nookagee site which would provide equivalent storage. Since the Whitmanville Lake project would contain 800 acre-feet (21%) of the total 3,800 acre-feet of the required augmentation, 21% of the total benefits ($116,000) were therefore accredited to Whitmanville Lake.

107. Recreation Benefits. - Studies by the Massachusetts Department of Natural Resources indicate the location and economic character of the region presents a good recreation potential if water contact sports are available. The use of most water bodies in the area is now restricted by their private ownership or use for public water supply. The recent construction of Interstate 495 through the area, the planned construction of a north-south highway from Worcester to Fitchburg and the improvement of Route 2 will assure easy access from the major metropolitan areas of Worcester, Lowell, and Boston. In addition, many summer tourists will traverse Route 495 on their way to New Hampshire and Maine.

The "Massachusetts Outdoor Recreation Plan 1966" prepared for the Massachusetts Department of Natural Resources outlines the recreation needs and goals of Massachusetts through the year 2000. The report shows that the average person over 12 years old participates in some form of recreation 58 days

each year with 15 days spent away from home and 43 days spent in the home environs. The water related activities of boating and swimming within a short distance of the home account for, on the average, three days per person per year. Assuming that the population within ten miles of the lake utilizes the lake only 10 percent of the time for this type of recreation experience, a total of 68,000 recreation days is involved. By applying growth factors, and allowing $1.25 per person per day, average annual benefits were estimated to be $125,000 per year for the economic life of the project.

An estimate of recreational benefits based upon specific uses resulted in an average annual benefit of approximately $125,400.00 as summarized:

Picnicking and swimming	40,000 @ $1.50	= $ 60,000.00
Hiking & conservation studies	5,000 @ $1.50	= 7,500.00
Winter sports	5,000 @ $1.50	7,500.00
Boating	1,000 @ $1.50	1,500.00
Fishing (warm water)	12,000 @ $2.00	24,000.00
Hunting (small game)	500 @ $2.00	1,000.00
Growth (within 10 years)	20,000 x $1.50 x 0.79798*	= 23,900.00
		$125,400.00

*Average annual equivalent compound interest factor.

DD. COST ALLOCATION

108. Allocation of Costs Among Purposes. - Costs of the multiple-purpose dam and lake allocated to the purposes of flood control, water quality control and recreation were made by the Separable-Costs Remaining Benefits method. A detailed breakdown of allocations among project purposes is shown in Appendix D. A summary follows:

Purpose	First Cost	Annual Charges
Flood Control	$5,370,000	$349,000
Recreation	1,230,000	93,000
Water Quality Control	1,150,000	78,000
TOTAL	$7,750,000	$520,000

109. Apportionment of Costs Among Interests. - The apportionment of costs to Federal and non-Federal interests including first costs, annual charges, and annual operation, maintenance and replacement costs is shown in Table 3. A detailed breakdown and a description of the basis for apportionment is included in Appendix D.

TABLE 3

COST APPORTIONMENT

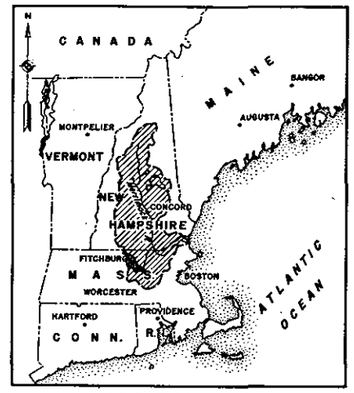
	Federal	Non-Federal	Total
First Costs			
Flood Control	$5,370,000		$5,370,000
Recreation	1,055,000	$175,000*	1,230,000
Water Quality Control	1,150,000		1,150,000
TOTAL FIRST COSTS	$7,575,000	$175,000	$7,750,000
Annual Charges			
Flood Control	$ 349,000		$ 349,000
Recreation	75,000	$ 18,000	93,000
Water Quality Control	78,000		78,000
TOTAL ANNUAL CHARGES	$ 502,000	$ 18,000	$ 520,000

* One-half separable first cost.

EE. RECOMMENDATION

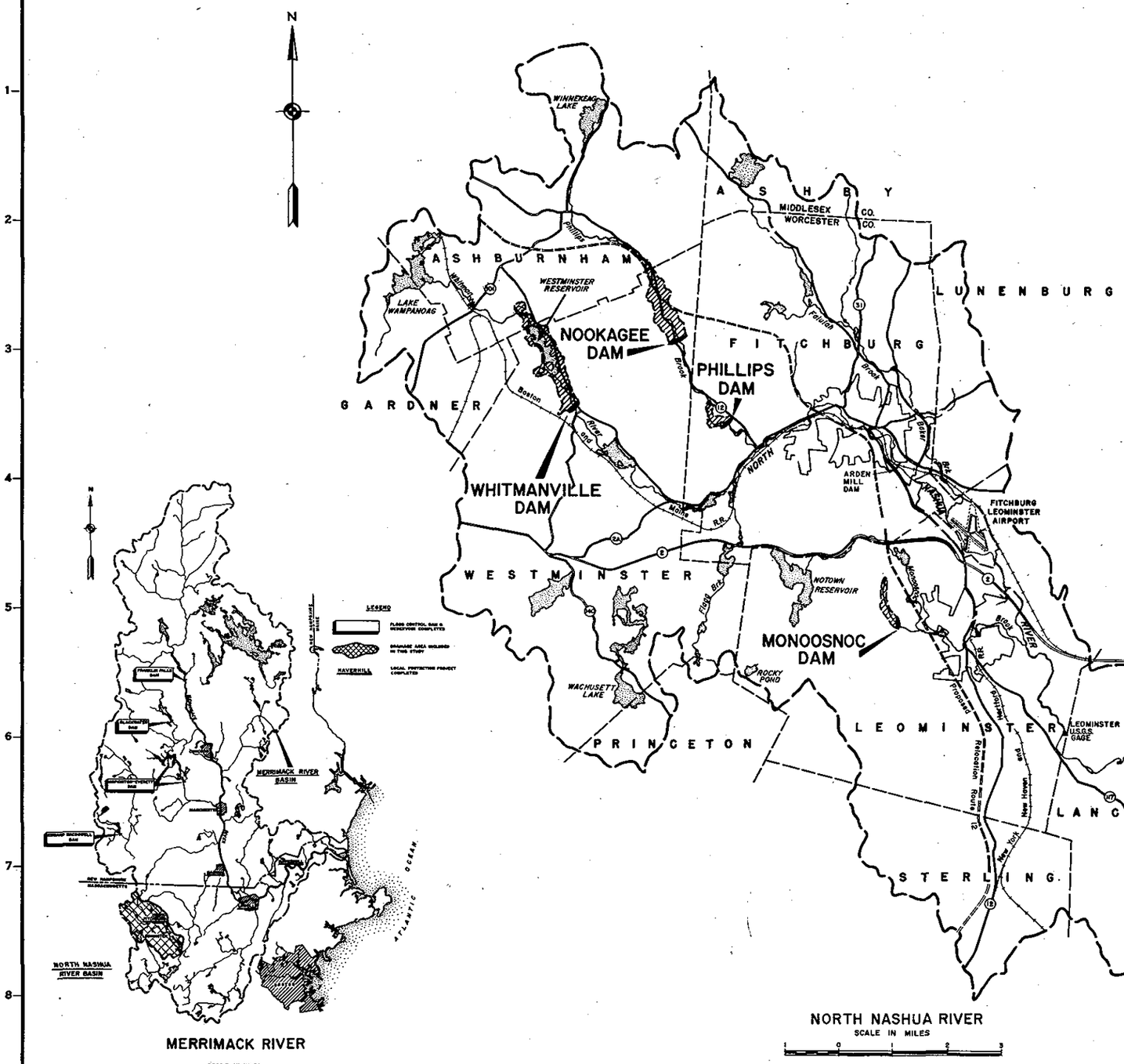
110. Recommendation. - The Whitmanville Lake project plan is the first installment of the implementation of the water resources plan for the North Nashua River Basin. It is recommended that the project plan (as reformulated) consisting of an earth fill dam, reservoir and appurtenant structures, to be located on the Whitman River in Westminster, Massachusetts, and providing multiple-use storage for flood control, water quality control and recreation, as submitted in this Memorandum, be approved as a basis for preparation of detailed Design Memoranda and contract plans and specifications.

CORPS OF ENGINEERS — U. S. ARMY



LOCATION MAP

SCALE IN MILES 25 0 25 50 75 100



MERRIMACK RIVER

SCALE IN MILES 4 0 4 8 12 16

LEGEND

DAM AND RESERVOIR AREA

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, FLOOD CONT. BRANCH
APPROVED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

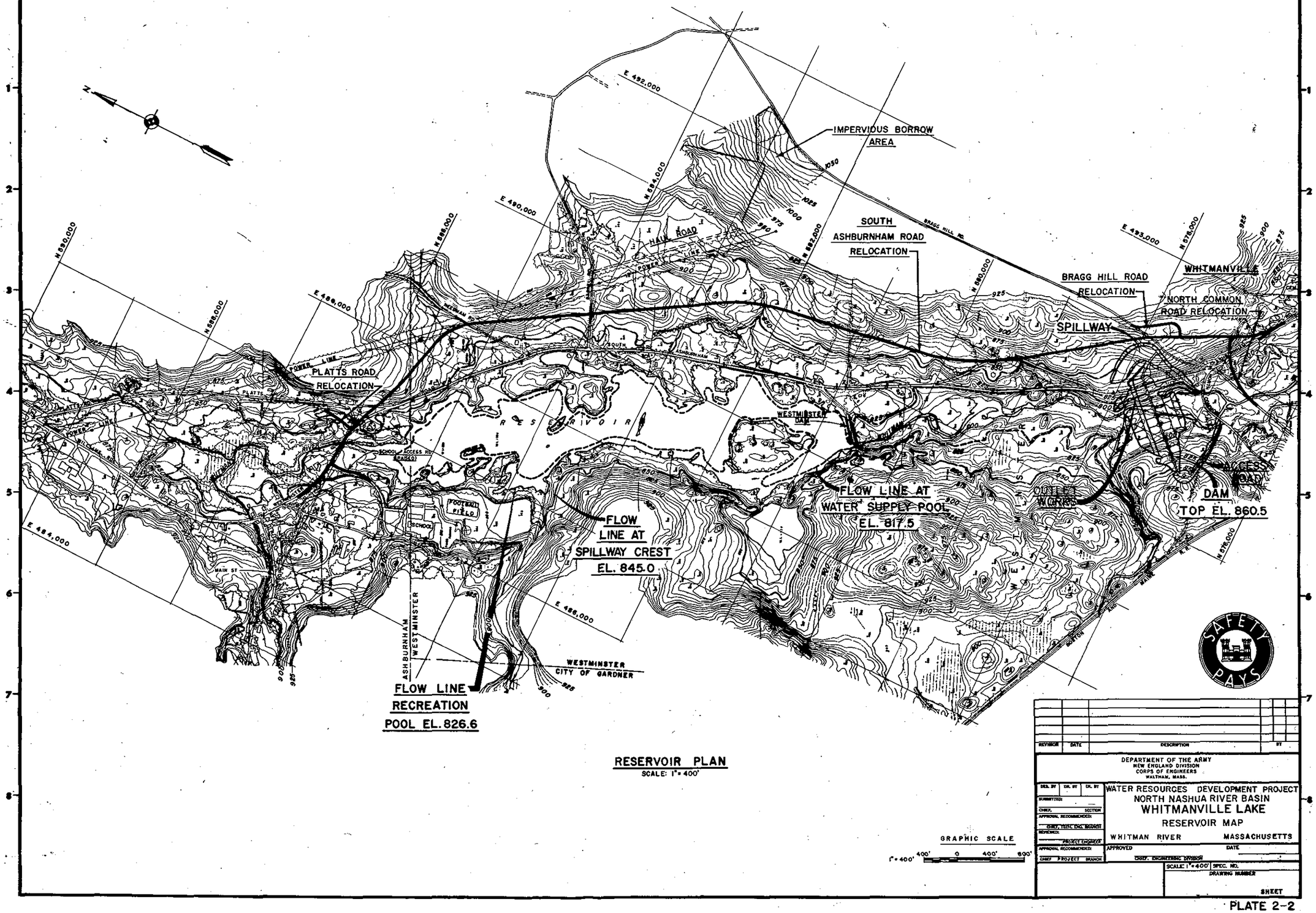
WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
WATERSHED MAP
WHITMAN RIVER MASSACHUSETTS

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2-I

CORPS OF ENGINEERS — U. S. ARMY



RESERVOIR PLAN
SCALE: 1" = 400'

GRAPHIC SCALE
1" = 400' 400' 0 400' 800'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, PERS. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
RESERVOIR MAP
WHITMAN RIVER MASSACHUSETTS

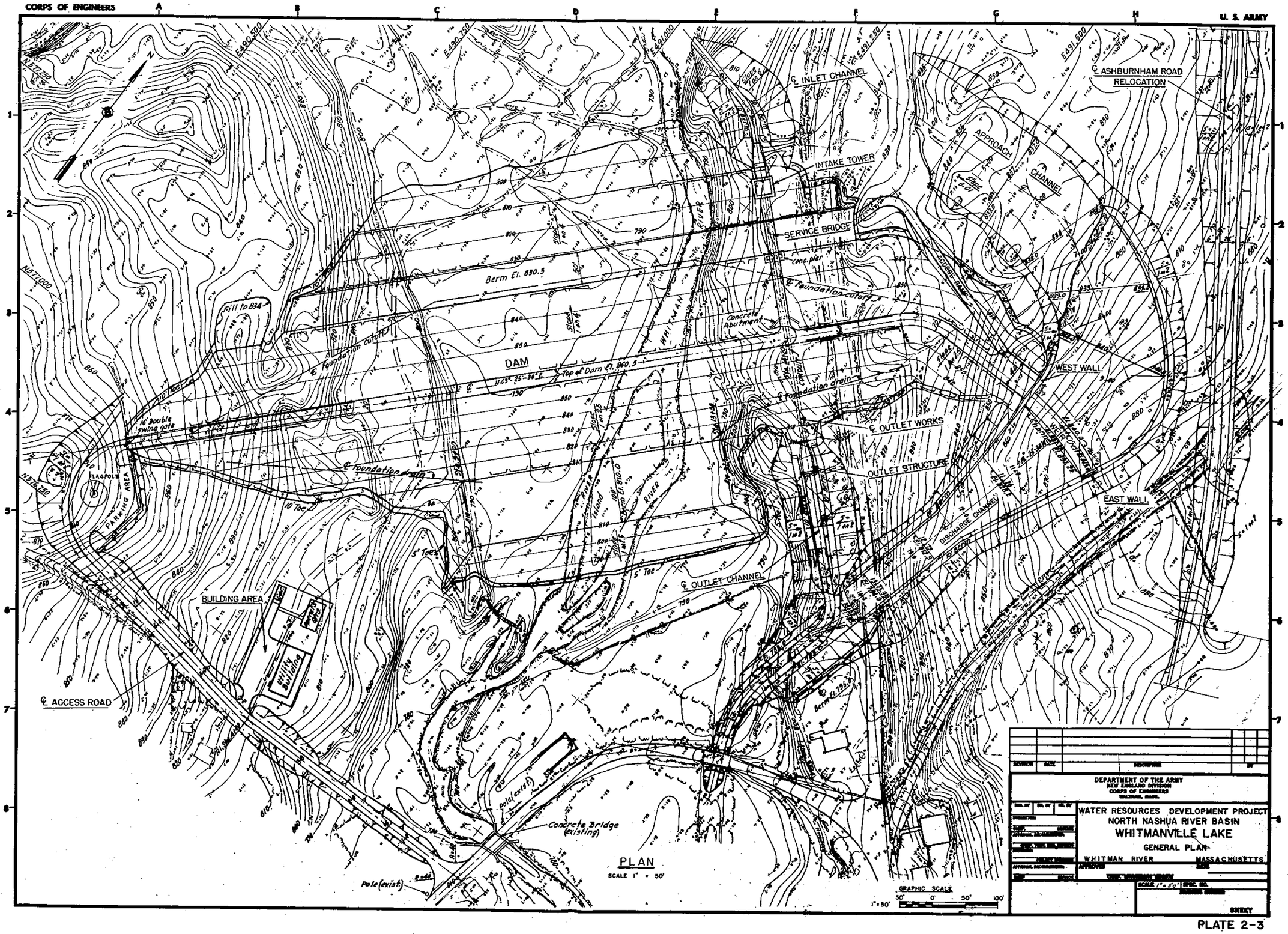
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE: 1" = 400' SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2-2

CORPS OF ENGINEERS

U. S. ARMY



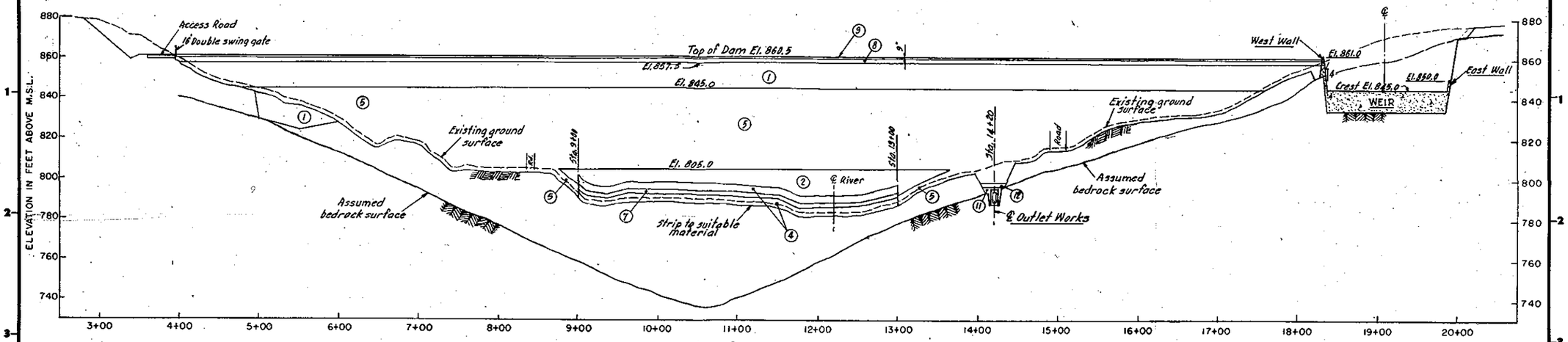
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
GENERAL PLAN
WHITMAN RIVER MASSACHUSETTS

SCALE 1"=50' SHEET

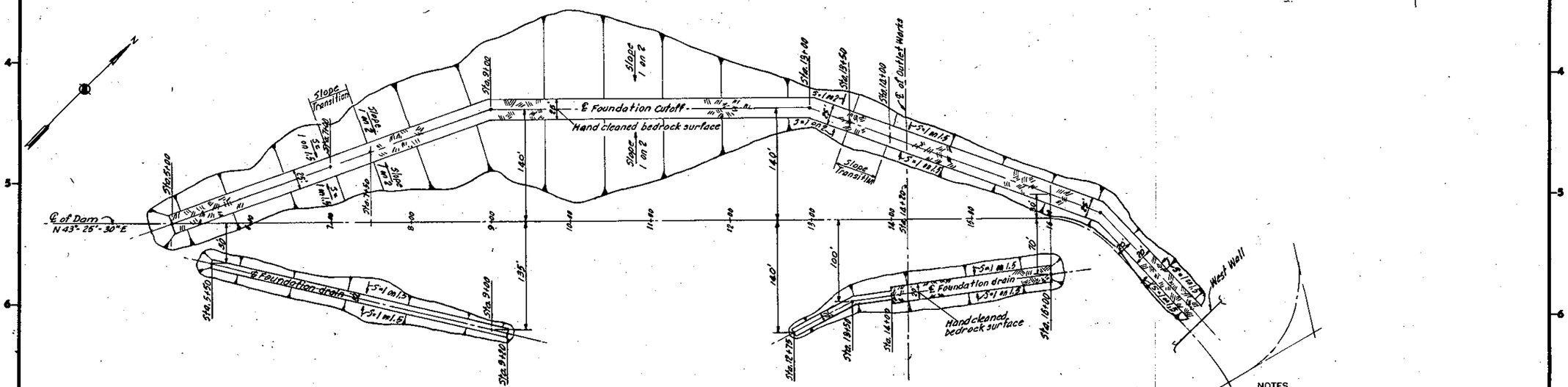
PLATE 2-3

CORPS OF ENGINEERS — U. S ARMY



PROFILE ON ℄ OF DAM AND SPILLWAY

SCALES: HOR: 1" = 50'
VERT: 1" = 20'



EXCAVATION PLAN- FOUNDATION CUT-OFF AND DRAINS

SCALE 1" = 50'

NOTES

For materials Legend see Plate 2-5.

SAFETY PAYS

GRAPHIC SCALES

1" = 20' — 20' 0 20' 40'

1" = 50' — 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF, SECTION
APPROVAL RECOMMENDED
CHIEF, TECH. ENGL. BRANCH
RECOMMEND
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF BRANCH

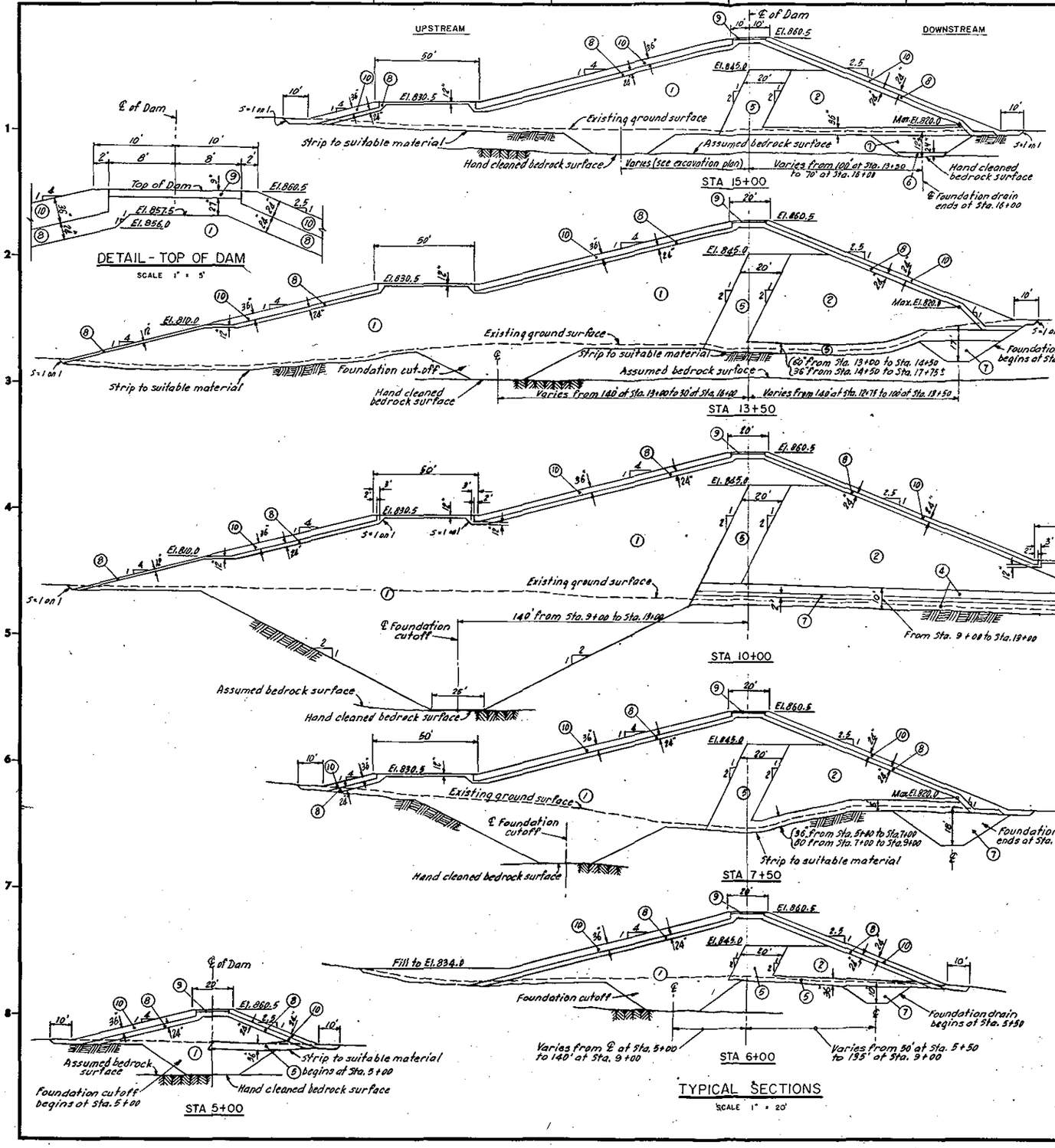
WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
DAM EMBANKMENT
PROFILE AND EXCAVATION PLAN
WHITMAN RIVER MASSACHUSETTS

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2-4

CORPS OF ENGINEERS — U. S ARMY



TYPICAL SECTIONS
SCALE 1" = 20'

FOUNDATION DRAIN DEPTHS			
STATION	DEPTH	STATION	DEPTH
5+50	10'	12+75	2'±
6+00	10'	13+00	5'±
6+50	10'	13+50	17'±
7+00	10'	14+00	12'± to bedrock
7+50	18'±	15+00	18'± to bedrock
8+00	10'	16+00	8'± to bedrock
8+50	10'		
9+00	6'±		
9+20	2'±		

Note: Depths to be measured from the existing ground surface.

LEGEND - MATERIALS	
MATERIAL DESIGNATION	DESCRIPTION
(1)	Compacted Impervious Fill.
(2)	Class I Compacted Random Fill.
(3)	Class II Compacted Random Fill.
(4)	Compacted Pervious Fill.
(5)	Compacted Sand Fill.
(6)	Compacted Gravel Fill.
(7)	Compacted Processed Sand Fill.
(8)	Gravel Bedding.
(9)	Road Gravel.
(10)	Rock Protection.
(11)	Compacted Impervious Backfill.
(12)	Compacted Gravel Backfill.
(13)	Topsoil
(14)	Uncompacted Impervious backfill.

NOTES

1. Foundation cutoff is 25 ft. wide from Sta. 5+00 to Sta. 15+60± and 20 ft. wide from Sta. 16+60± to Spillway Ret. wall.
2. Side slopes of foundation cutoff are 1 on 1.5 from Sta. 5+00 to Sta. 7+00, vary from 1 on 1.5 at Sta. 7+00 to 1 on 2 at 7+50, are 1 on 2 from Sta. 7+50 to Sta. 13+50, vary from 1 on 2 at Sta. 13+50 to 1 on 1.5 at Sta. 14+00 and are 1 on 1.5 from Sta. 14+00 to Spillway Ret. wall.
3. Right abutment foundation drain is 10 ft. wide from Sta. 5+50 to Sta. 9+20±.
4. Left abutment foundation drain is 10 ft. wide from Sta. 12+75 to Sta. 14+00 and 20 ft. wide from Sta. 14+00 to Sta. 16+00.
5. Side slopes of foundation drains are 1 on 1.5.
6. Widths and side slopes of foundation cutoff and foundation drains are measured at right angles to their centerlines.

GRAPHIC SCALES
1" = 5' — 5' 0 5' 10'
1" = 20' — 20' 0 20' 40'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

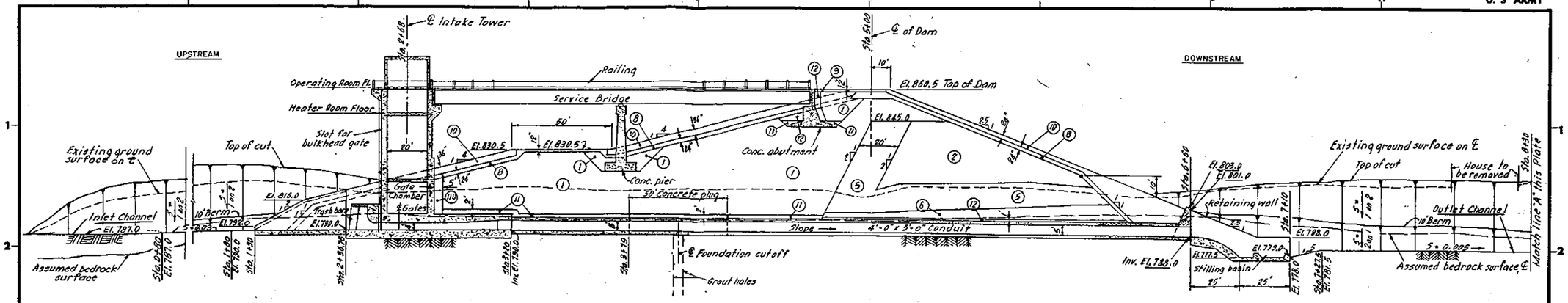
DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
APPROVAL RECOMMENDED
CHIEF, TECH. ENG. BRANCH
REVIEWED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
DAM EMBANKMENT
SECTIONS
WHITMAN RIVER MASSACHUSETTS
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

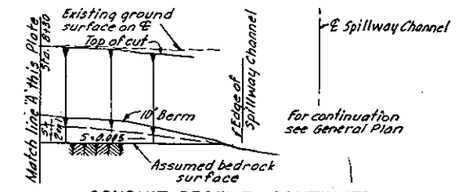
PLATE 2-5

CORPS OF ENGINEERS — U. S ARMY



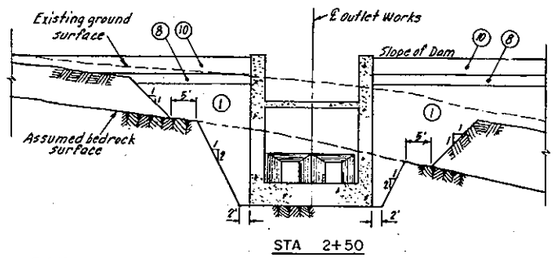
CONDUIT PROFILE

SCALE 1" = 20'

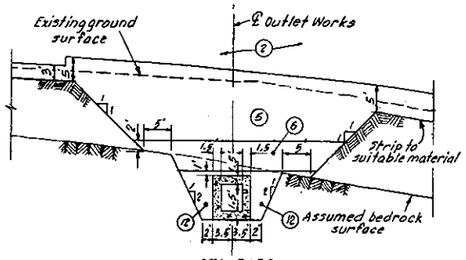


CONDUIT PROFILE - CONTINUED

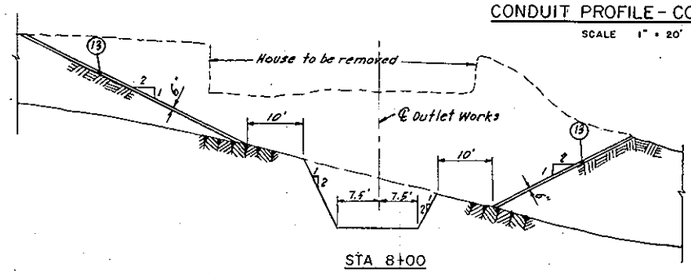
SCALE 1" = 20'



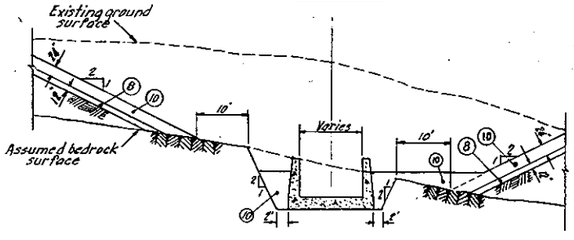
STA 2+50



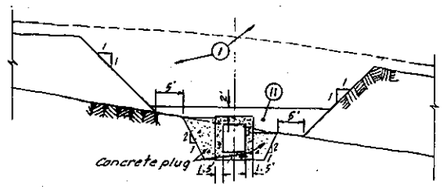
STA 5+50



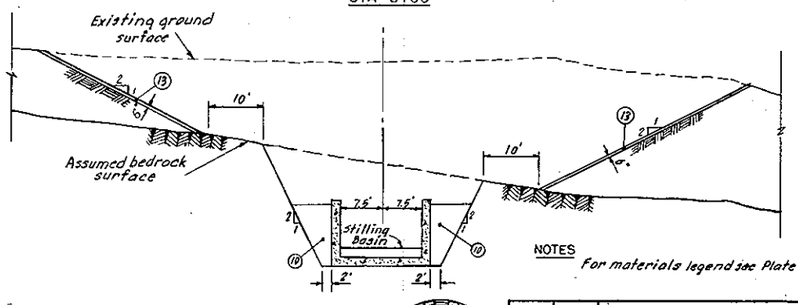
STA 8+00



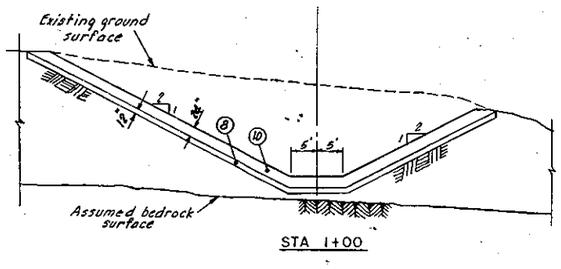
STA 2+00



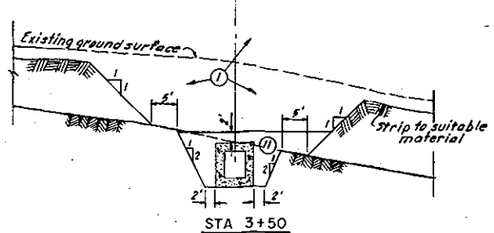
STA 4+00



STA 7+00



STA 1+00



STA 3+50

TYPICAL SECTIONS

SCALE 1" = 10'

NOTES

For materials legend see Plate 2-5.

GRAPHIC SCALES

1" = 10' 10' 0 10' 20'

1" = 20' 20' 0 20' 40'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED

CHIEF, SECTION

APPROVAL RECOMMENDED:

CHIEF, PROJ. ENG. BRANCH

REVIEWED:

PROJECT ENGINEER

APPROVAL RECOMMENDED:

CHIEF ENGINEERING BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
OUTLET WORKS
CONDUIT - PROFILE AND SECTIONS
WHITMAN RIVER MASSACHUSETTS

APPROVED DATE

CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.

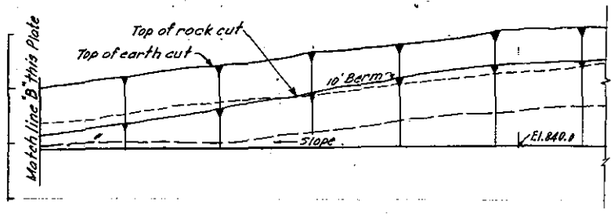
DRAWING NUMBER

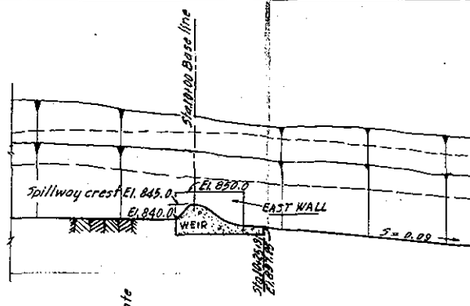
SHEET

PLATE 2-6

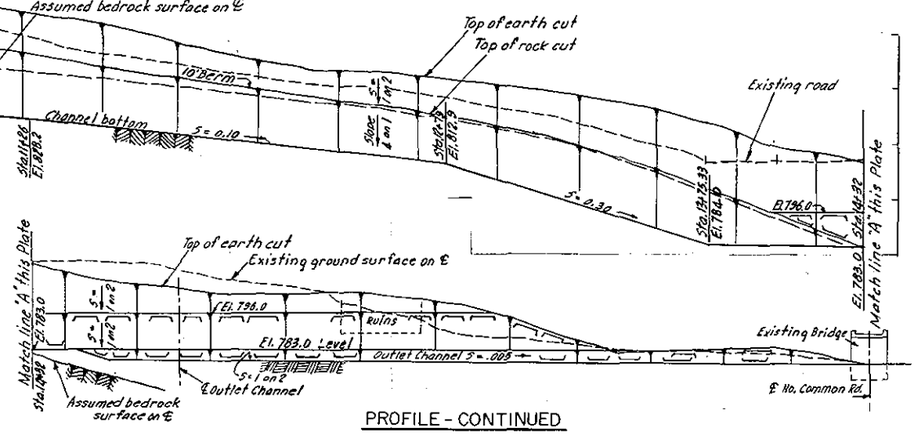
CORPS OF ENGINEERS — U. S ARMY

APPROACH CHANNEL

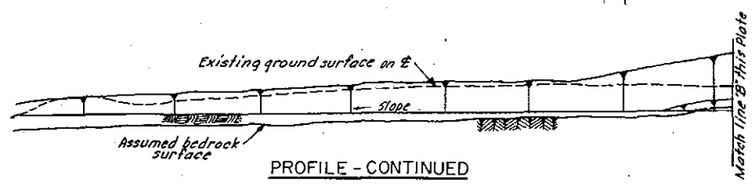




DISCHARGE CHANNEL

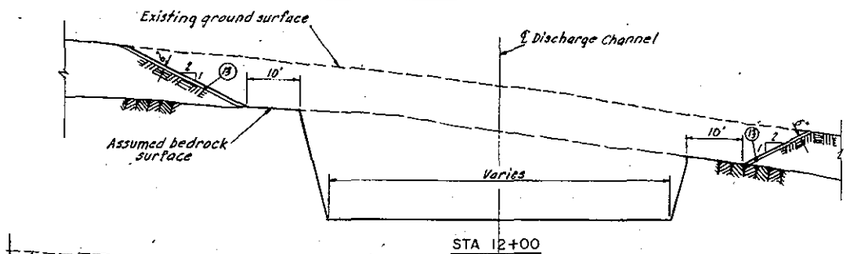


PROFILE ON ℄ OF CHANNEL
SCALE 1" = 20'

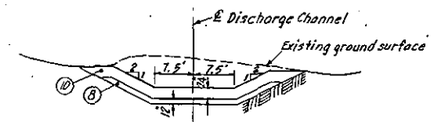


PROFILE - CONTINUED

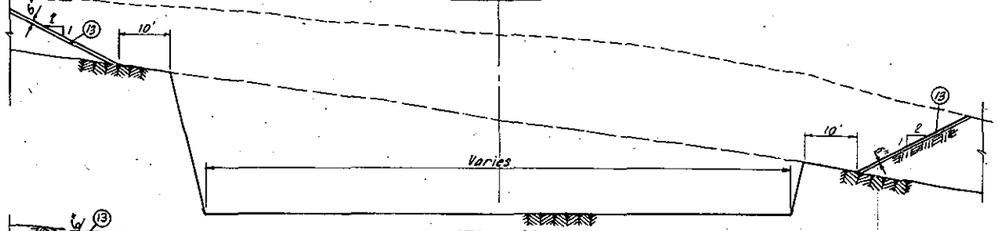
PROFILE - CONTINUED



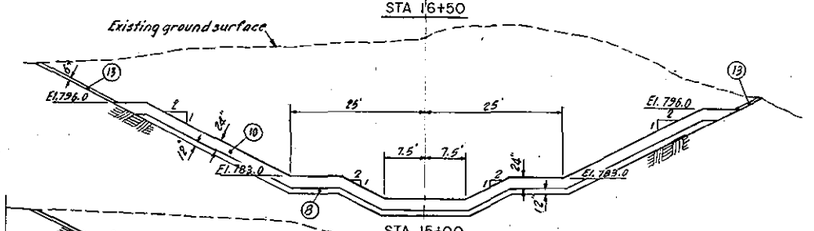
STA 12+00



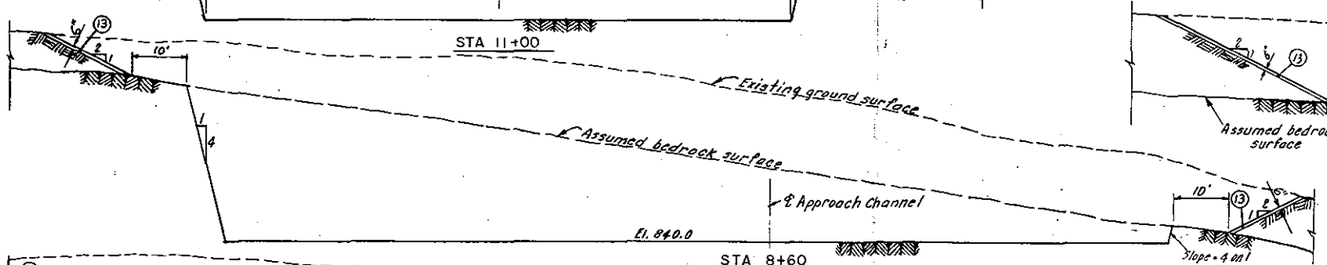
STA 16+50



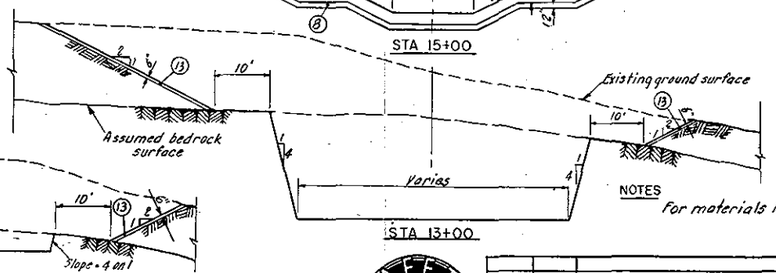
STA 11+00



STA 15+00

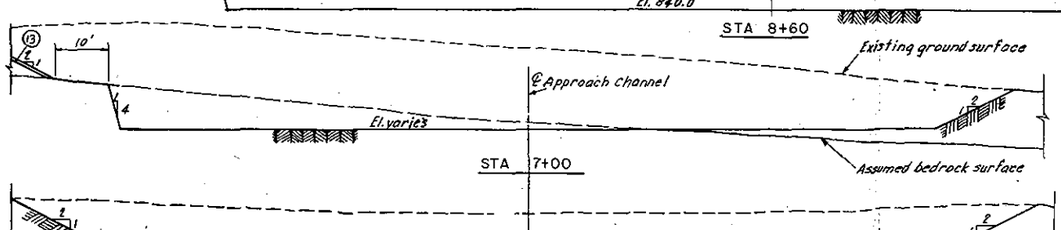


STA 8+60

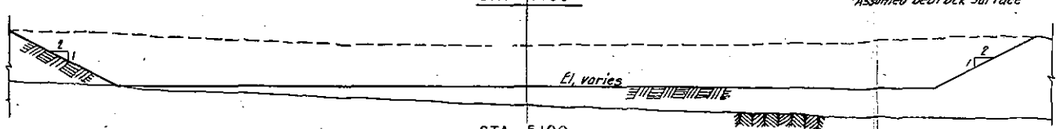


STA 13+00

NOTES
For materials legend see Plate 2-5.



STA 7+00



STA 5+00

TYPICAL SECTIONS
SCALE 1" = 10'

GRAPHIC SCALES
1" = 10' 10' 0 10' 20'
1" = 20' 20' 0 20' 40'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF, SECTION
APPROVAL RECOMMENDED
CHIEF, ENGR. BRANCH
REVIEWED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
SPILLWAY
PROFILE AND SECTIONS
WHITMAN RIVER MASSACHUSETTS

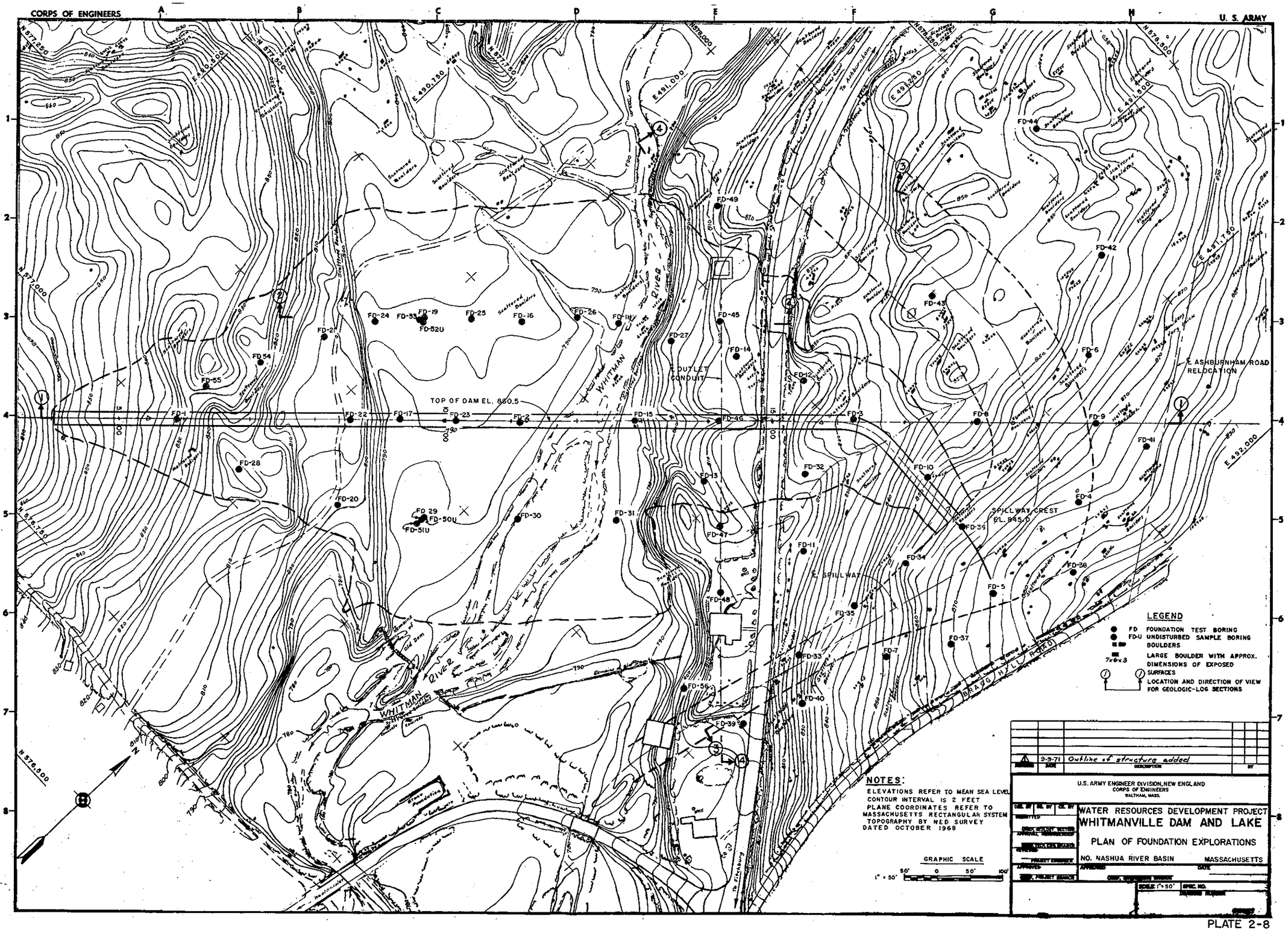
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2-7

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

- FD FOUNDATION TEST BORING
- FD-U UNDISTURBED SAMPLE BORING
- BOULDERS
- 7'x6'x3' LARGE BOULDER WITH APPROX. DIMENSIONS OF EXPOSED SURFACES
- LOCATION AND DIRECTION OF VIEW FOR GEOLOGIC-LOG SECTIONS

NOTES:

ELEVATIONS REFER TO MEAN SEA LEVEL
CONTOUR INTERVAL IS 2 FEET
PLANE COORDINATES REFER TO MASSACHUSETTS RECTANGULAR SYSTEM
TOPOGRAPHY BY NED SURVEY DATED OCTOBER 1968

GRAPHIC SCALE
1" = 50'
0 50' 100'

MARK	DATE	DESCRIPTION	BY
1	9-9-71	Outline of structure added	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT

WHITMANVILLE DAM AND LAKE

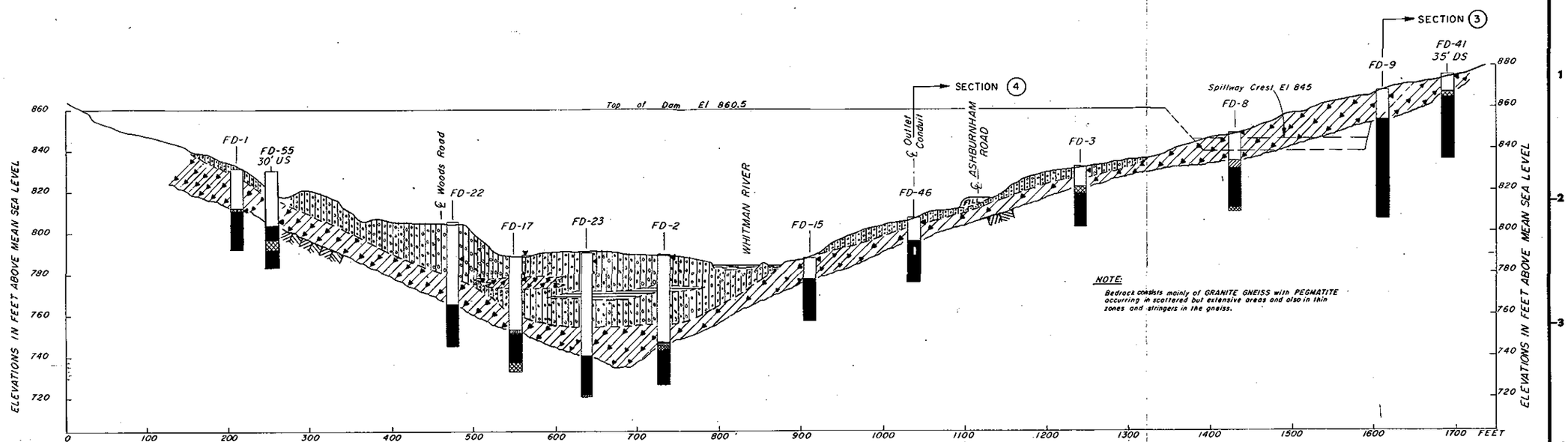
PLAN OF FOUNDATION EXPLORATIONS

NO. NASHUA RIVER BASIN MASSACHUSETTS

SCALE 1"=50' SPEC. NO.

PLATE 2-8

CORPS OF ENGINEERS A B C D E F G H U. S ARMY

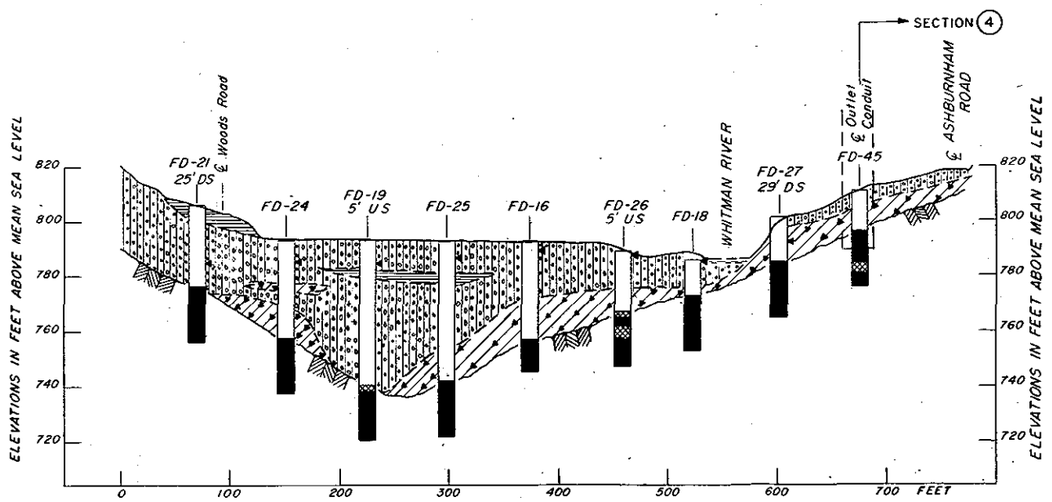


SECTION 1-1 CENTERLINE OF DAM

(LOOKING UPSTREAM)

NOTE:

Bedrock consists mainly of GRANITE GNEISS with PEGMATITE occurring in scattered but extensive areas and also in thin zones and stringers in the gneiss.



SECTION 2-2 150' UPSTREAM FROM ℄ DAM

(LOOKING UPSTREAM)

LEGEND

- Assumed Bedrock Surface
- Stratified and lensed silty and/or gravelly SAND and silty and/or sandy GRAVEL with scattered cobbles and boulders
- Stratified sandy to clayey SILT and CLAY
- Variable, silty and gravelly SAND and silty, sandy GRAVEL with numerous cobbles and boulders (TILL)
- FD- Foundation Test Boring
- Maximum Artesian Head
- Subsurface Water Level during exploration
- Rock Core Recovery
  - 0 - 25 %
  - 25 - 50 %
  - 50 - 75 %
  - 75 - 90 %
  - 90 - 100%

NOTES:

For location of sections see Plate 2-8

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY

SUBMITTED:
CHIEF, GEOLOGY SECTION
APPROVAL RECOMMENDED:
CHIEF FIELD BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

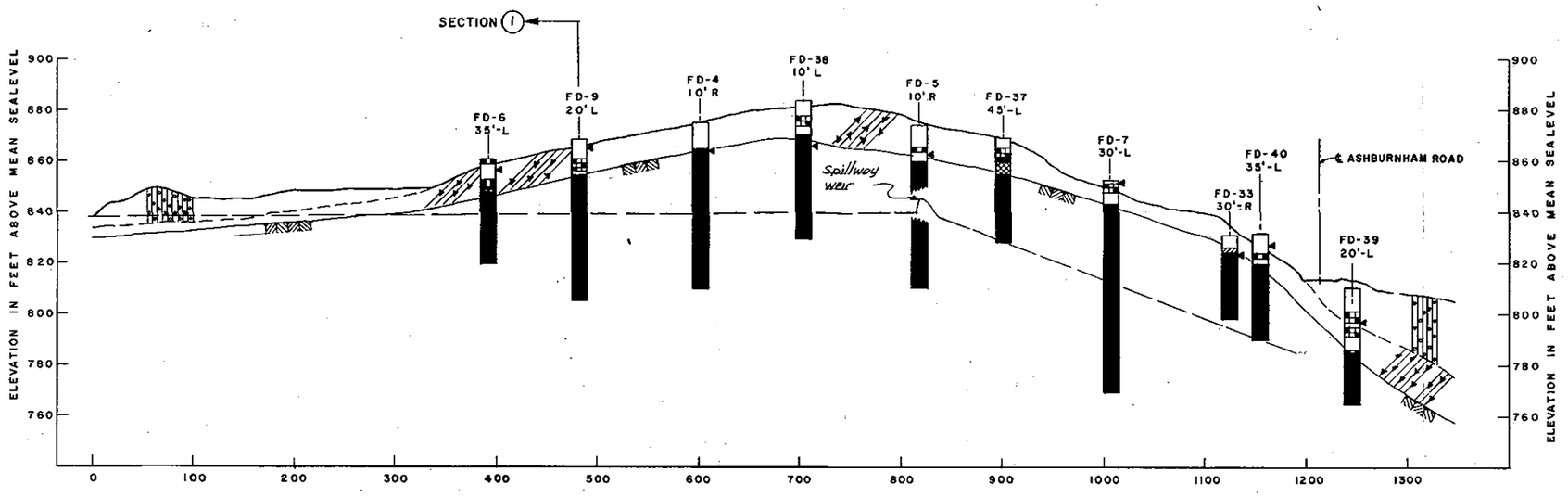
WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
DAM
GEOLOGIC - LOG SECTIONS
WHITMAN RIVER MASSACHUSETTS

APPROVED DATE
CHIEF, ENGINEERING DIVISION

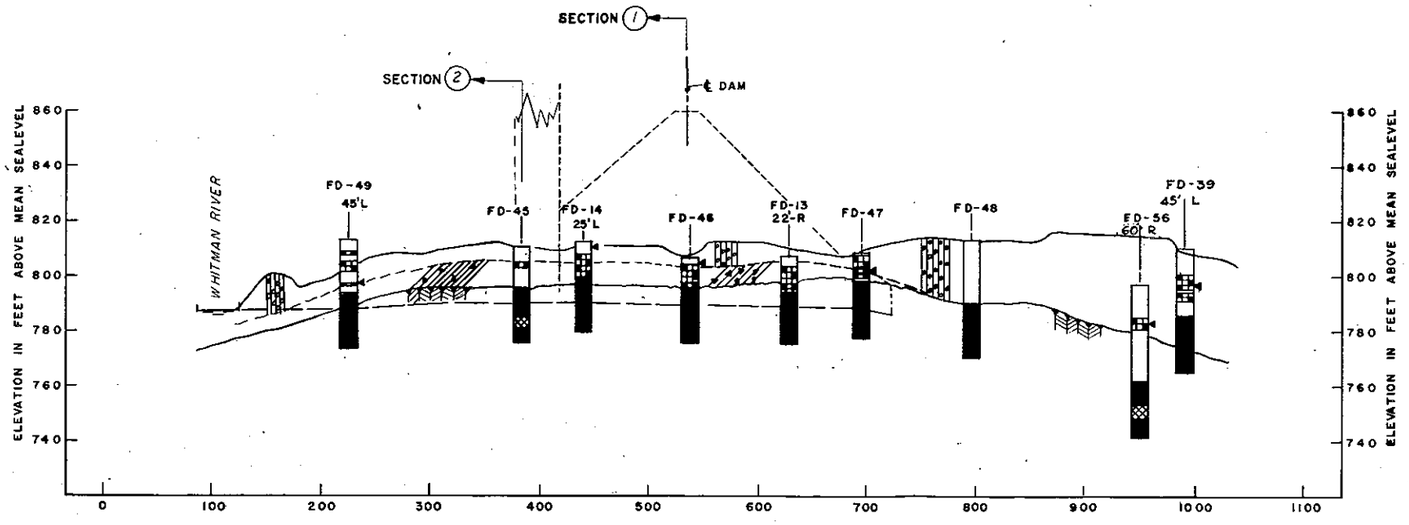
SCALE , SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2-9

CORPS OF ENGINEERS A B C D E F G H U. S ARMY



SECTION 3-3 SPILLWAY



SECTION 4-4 ℄ OUTLET CONDUIT

NOTES

For location of sections see Plate 2-8.
For legend for geologic log sections see Plate 2-9.

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY H A V | DR. BY J B M | CK. BY

SUBMITTED:
CHIEF, GEOLOGY SECTION
APPROVAL RECOMMENDED:
CHIEF F&M BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
SPILLWAY AND OUTLET CONDUIT
GEOLOGIC - LOG SECTIONS
WHITMAN RIVER MASSACHUSETTS

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2-10

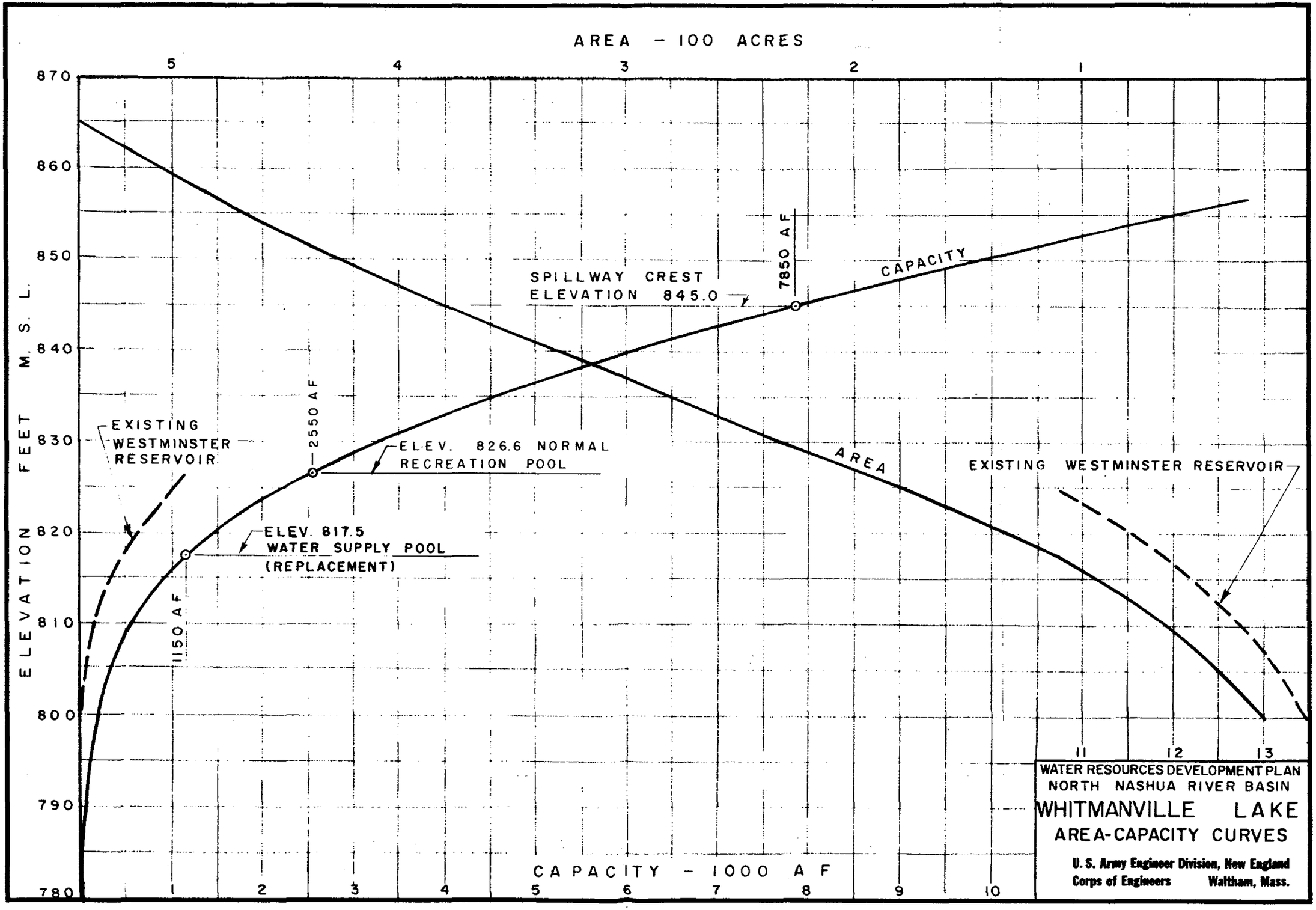

AREA - 100 ACRES
5
4
3
2
1
870
860
850
840
830
820
810
800
790
780
ELEVATION FEET M. S. L.
SPILLWAY CREST
ELEVATION 845.0
7850 A F
CAPACITY
EXISTING
WESTMINSTER
RESERVOIR
2550 A F
ELEV. 826.6 NORMAL
RECREATION POOL
AREA
EXISTING WESTMINSTER RESERVOIR
ELEV. 817.5
WATER SUPPLY POOL
(REPLACEMENT)
1150 A F
1
2
3
4
5
6
7
8
9
10
11
12
13
CAPACITY - 1000 A F
WATER RESOURCES DEVELOPMENT PLAN
NORTH NASHUA RIVER BASIN
WHITMANVILLE LAKE
AREA-CAPACITY CURVES
U. S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.

PLATE 2-11

APPENDIX A

LETTER OF APPROVAL

REPORT: JUSTIFICATION FOR ALTERING PROJECT PURPOSES

ENGCW-EZ (NEDED-E, 12 Feb 71) 1st Ind
SUBJECT: Whitmanville Dam and Lake, Whitman River - Nookagee Dam and Lake, Phillips Brook, North Nashua River Basin, Justification for Altering Project Purposes

DA, Office of the Chief of Engineers, Washington, D.C. 20314 28 May 1971

TO: Division Engineer, New England, ATTN: NEDED-E

1. The subject memorandum is satisfactory as a basis for further planning, subject to the following comments.

2. Basic letter, paragraph 3. Construction of the subject projects with an authorized purpose omitted (industrial water supply) will require further Congressional action. Accordingly, drafts of letters to appropriate Congressional committees describing the recommended departures from the authorized project document plan should be prepared and submitted to initiate the required Congressional action (see the penultimate sentence of paragraph 1g of Appendix I to ER 1110-2-1150).

3. Paragraph 5. Minimum recreation facilities should be planned for Nookagee even though the project will not be ideal for recreation. There are many kinds of recreation that can be enjoyed even with a pool which fluctuates.

4. Exhibit 9. For the Whitmanville Dam and Lake/Nookagee Dam and Lake system, the most reasonable single-purpose water quality alternative would appear to be development of the Nookagee site to obtain all the Water Quality storage needed to meet stipulated requirements. Limiting costs and benefits derivable from the estimated costs for such development would be apportionable between Whitmanville and Nookagee on the basis of the Water Quality storage proposed in each in accordance with the reformulated project plan. This is in contrast to the separate single-purpose alternatives assumed for the allocations of costs presented in the subject report.

FOR THE CHIEF OF ENGINEERS:

1 Incl
wd

JOSEPH M. CALDWELL
Chief, Engineering Division
Civil Works Directorate

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION: CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO
NEDED-E

12 February 1971

SUBJECT: Whitmanville Dam and Lake, Whitman River - Nookagee Dam and Lake, Phillips Brook, North Nashua River Basin, Justification for Altering Project Purposes

Chief of Engineers
ATTN: ENGCW-E

1. Submitted for your review and approval is a Memorandum entitled "Justification for Altering Project Purposes for the Whitmanville and Nookagee Dams and Lakes." The projects are located in the North Nashua River Basin, Massachusetts.

2. This Memorandum describes the events that initiated re-evaluation of the projects' purposes and the analyses undertaken in the reformulation.

3. Both projects are currently funded for design. Subsequent to your review and approval, correspondence will be drafted to report the recommended changes to the Public Works and Appropriations Committees of Congress and to the Office of Management and Budget.

Frank P. Bane

FRANK P. BANE
Colonel, Corps of Engineers
Division Engineer

1 Incl
as (14 cys)

JUSTIFICATION FOR ALTERING PROJECT PURPOSES

WHITMANVILLE DAM AND LAKE

NOOKAGEE DAM AND LAKE

NORTH NASHUA RIVER BASIN, MASSACHUSETTS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS
FEBRUARY 1971

JUSTIFICATION FOR ALTERING PROJECT PURPOSES

WHITMANVILLE AND NOOKAGEE DAMS AND LAKES NORTH NASHUA RIVER BASIN, MASSACHUSETTS

1. GENERAL. - This report sets forth the events that initiated re-evaluation of the purposes of the Whitmanville and Nookagee Projects, North Nashua River Basin, Massachusetts, and relates the analysis undertaken toward redefining the concepts of the projects.

2. AUTHORIZED PROJECTS. - The Whitmanville and Nookagee Projects were authorized by Public Law 89-789, 89th Congress, substantially in accordance with the recommendations of the Chief of Engineers as contained in Senate Document No. 113, 89th Congress. Whitmanville was authorized with flood control and industrial water supply as project purposes, while the project purposes for Nookagee included recreation in addition to flood control and industrial water supply. Pertinent data pertaining to both projects, as contained in the authorizing document, is inclosed (Exhibit 1).

3. WITHDRAWAL OF SUPPORT FOR WATER SUPPLY. - In September 1969, the local interests, through Mayor William G. Flynn, City of Fitchburg, Mass., withdrew their support for the water supply aspects of both projects (Exhibit 2). It is noted that at Whitmanville, the withdrawal of support pertained to the additional industrial water contemplated above and beyond the amount the project was obligated to replace as a result of inundation of the existing Westminster water supply reservoir. Adjacent communities were advised of the potential source; some expressed interest in the sites as sources of domestic water supplies. Unfortunately, the quality of water in the rivers requires extensive treatment and piping, the cost of which discouraged these communities from further consideration. The additional water supply at both reservoirs, as contained in the survey report, did not include the cost of a distribution system since it was envisioned that the water would be for industrial purposes and would be released into the rivers where the industrial plants could draw from the rivers as needed. As a result of withdrawal of support, the water supply aspects at both sites, with the exception of replacement obligation, have been deleted.

Strong interest remains for the flood control, water quality and recreational aspects of the projects, as evidenced in the letter, dated

25 November 1969, from Mayor Flynn to Senator Edward M. Kennedy (Exhibit 3) and as expressed in numerous meetings by Selectmen, conservation groups, State agencies, and residents of the communities in the vicinity.

4. INCLUSION OF WATER QUALITY STORAGE. - During the review of the 1965 Survey Report of the North Nashua River Basin, the Department of Health, Education and Welfare, pointed out the need for providing in these projects storage for water quality (W.Q.) to supplement the waste treatment program. HEW stated that their studies "indicate that presently available treatment methods cannot alone control the polluted condition of the stream" (North Nashua River) and "even partial provisions for stream flow regulation would result in substantial quality improvement with attendant benefits within the study area." In response, the Chief of Engineers assured HEW that "prior to initiation of construction, studies will be made concerning the need for storage for water quality control." (Exhibit 4)

Since the issuance of the report, the Federal Water Quality Administration (FWQA) has set up minimum flow requirements for water quality control in the North Nashua River (Exhibit 5). Sheets 1 and 2 of Exhibit 5 present the justification and the minimum flow requirements for water quality as measured at the Leominster gage and as appeared in the FWPCA's New England River Basin Report, dated April 1968. Sheets 3 and 4 update the minimum flow requirements based upon measurements upstream of the Leominster gage. With the targets set by the FWQA, the New England Division determined the storage and releases necessary to meet these requirements. The study revealed that a storage of 3,800 acre-feet would provide the water needed for flow augmentation for water quality with 95% dependability. A detailed analysis of the water quality requirements will be included in the Supplement to Design Memorandum No. 1, Hydrology, expected to be submitted in March 1971.

The water quality aspects of the Whitmanville and Nookagee projects will be beneficial to the Nashua River Basin Demonstration Project being planned by the Program Management Group which is chaired and staffed by the New England River Basins Commission and includes representatives from the Massachusetts Division of Water Pollution Control, the New Hampshire Water Supply and Pollution

Control Commision, the New England Interstate Pollution Control Commission and FWQA. Their objective is to demonstrate to the rest of the Country that with proper planning and with reasonable financial backing that an interstate river (North Nashua and Nashua Rivers) can be converted from an open sewer to a viable public waterway and attractive recreational area. The New England Regional Commission in December 1970 allocated $1.5 million of its 1971 budget to support this demonstration project. The Program Management Group has indicated that even in the early stage of their planning they are aware of the need of flow augmentation for water quality from Whitmanville and Nookagee in order to reach their objective. Construction of the two sewage treatment facilities for the City of Fitchburg, which is essential to the water quality program and the Demonstration Project, is scheduled to begin in July 1971 and become operational in 1973.

5. PROJECT FORMULATION.

a. Storage Capacity Revision. - Upon recalculating the capacity of the Whitmanville Lake based upon more detailed mapping, the capacity at full pool (El. 845.0 msl) was found to be 7,850 acre-feet instead of 9,350 acre-feet estimated in the survey report; a decrease of approximately 16%. The decrease in capacity of 1,500 acre-feet was approximately equivalent to the 1,530 acre-feet of additional industrial water contemplated at Whitmanville. Further investigation revealed that the regional high school (valued at $3.0 million in 1969) was built at an elevation which would not permit, economically, raising the dam to regain the loss in capacity. The result of this development meant that by holding the spillway crest to El. 845.0 at Whitmanville, the capacity would be sufficient to accommodate the authorized flood control storage of 6,700 acre-feet as well as compensate for the existing storage of 1,150 acre-feet in Westminster Reservoir. Any additional storage needs at Whitmanville for supplementary purposes, i.e., recreation or W.Q., would have to be by reducing the flood storage or by seasonal encroachment on part of the flood control storage.

b. Drawdown Consideration. - The restrictions at Whitmanville compelled the planners to look to Nookagee to provide the bulk of the storage for water quality. Six plans were derived, studied and assessed. During the period of assessment, it became evident that the magnitude of drawdowns at the Nookagee site would dictate the

extent of the recreational development at that particular site. Releases from the reservoir for water quality would come at the time when the recreational demands would be the greatest and based upon past experience, drawdowns greater than 3 to 5 feet are considered excessive and detrimental to recreation by exposing large unsightly areas along the shoreline. A study of drawdown ranges and frequencies was undertaken (Exhibit 6). Results of the study revealed that, if the augmentation from the two lakes were made in proportion to the total storage allotted to water quality, i.e., 1,500 a.f. @ Whitmanville and 2,300 a.f. @ Nookagee, the drawdowns at Nookagee would be approximately 10 feet (end of September) on the average year commencing in the first week of July and during dry years the drawdown would be as much as 15 feet (Exhibit 6, Sh. 1). A further study revealed that if the water quality releases at Nookagee (2,300 a.f.) were conserved until the storage at Whitmanville (1,500 a.f.) was consumed, the drawdown at Nookagee for the average year, commencing at the end of the fourth week in July, would be 7.5 feet and during dry years as much as 14 feet (Exhibit 6, Sh. 2). Conversely, a study based upon conserving the water quality storage at Whitmanville until the 2,300 a.f. of storage at Nookagee was released, showed that for the average year the releases from Nookagee would satisfy the demands until mid-September and for 1 in 10 dry years would satisfy the demands until mid-August. It was further shown that by increasing the water quality storage at Nookagee from 2,300 a.f. to 3,000 a.f. that even during the driest year the drawdown at Whitmanville due to water quality releases would not start until the first week of September (Exhibit 6, Sh. 3).

c. Recreational Development. - The drawdown analysis terminated with the conclusion that the most favorable site for recreational development would be at Whitmanville.

The latest Outdoor Recreation Plan for the Commonwealth of Massachusetts identified the area surrounding the Fitchburg-Leominster metropolitan and northern Worcester County area as having a large unsatisfied demand for water-based day use recreation. Willard Brook State Park, the nearest public swimming area, already supports use by 100,000 recreators with an available water area of less than 20 acres. The combination of available water surface and topographic configuration at Whitmanville reservoir makes it an ideal location for a major day-use recreation facility. At present, we envision a recreational

development capable of supporting annual visitation in the range of 100,000. The major features of the recreation facility will be swimming, picnicking, boating, fishing, hiking and camping. The westerly shore will be reserved for recreation activities such as hiking, hunting, nature study, etc.

The fortuitous combination of a scenic yet easily developable shoreline with relatively stable pool levels would make Whitmanville Reservoir the focal point of recreation over a considerable area. By capitalizing on the opportunity to develop this resource, we can provide the citizens of Massachusetts and southwestern New Hampshire with the type of facility that is sorely needed in the area.

d. Maximization of Benefits. - The riverbanks in Fitchburg and Leominster for a distance of 4.5 ± miles are completely built over with commercial and industrial properties in which a large portion of the area's work force are employed. Both cities are heavily populated with densities of 1,566 and 1,135 persons per square mile, respectively. A high degree of protection is required for such an area, particularly for the safety and security of its populace. A complete analysis of the maximization of flood control benefits is presently under way and will be incorporated in the General Design Memorandum. The authorized flood protection, equivalent to 7.2 inches and 8.0 inches of runoff at Whitmanville and Nookagee respectively, is considered at this time to be the minimum protection desirable. The limited number of potential sites in the North Nashua River Basin leaves little room for altering the location or scope of the flood protection.

e. Plans Refined. - The analyses resulted in the evolution of two plans - Plan A and B (Exhibit 7). In both plans, seasonal encroachment on the flood control storage at Whitmanville is envisioned to gain the storage necessary for recreation and water quality while maintaining the spillway crest at El. 845.0.

The following summarizes Plans A and B:

PLAN A.

Whitmanville Lake. Total storage capacity of 7,850 acre-feet equivalent to 8.4 inches of runoff. The total storage has allocations of: 1,150 acre-feet (1.2 inches) to replace existing water supply at Westminster Reservoir which will be inundated by the dam; 5,300 acre-feet

(5.7 inches) for flood control; and 1,400 acre-feet (1.5 inches) seasonal joint-use for flood control and recreation. Operationally the full flood control storage of 6,700 acre-feet will be available from September (after Labor Day) through March. Toward the end of the spring runoff in April, a recreation pool would be established by retaining 1,400 acre-feet within the flood control zone. This seasonal pool would be retained until the close of the recreation season in September. At that time the pool would be lowered to provide full flood control storage. The magnitude of drawdown of the summer pool would be a function of the paper industry's demand upon its existing water supply. It is noted that if the industry used up to 50% of their storage at Whitmanville, the drawdown would approximate 3.3 feet.

Records of drawdowns of the existing Westminster Reservoir by the industrial users have not been maintained, consequently, an attempt was made during the 1970 recreation season to observe the effects of the demands on the Westminster site. By Labor Day it was noted that the withdrawal amounted to approximately 620 acre-feet or 54% of the total storage. The precipitation for the first 9 months of 1970 was determined to be approximately 2 inches less than the precipitation for a 96 year mean. Projecting the effect of the 1970 water usage on the authorized project would have lowered the water surface level approximately 3.4 feet. Withdrawal of the industrial water from the new lake, based upon the expected maximum use of the industrial allotment, would lower the water surface 5.4 feet and would result in a less attractive recreation pool during abnormally dry years. A drawdown range of 3.3 to 5.4 feet is considered tolerable; however, the Massachusetts Department of Natural Resources, the principal non-Federal participant in the recreational development at Whitmanville, has requested that drawdowns of the recreational pool be limited to 1 to 2 feet. To meet this stringent requirement an investigation was undertaken to determine if the existing Westminster Dam (located 3/4 miles upstream of the new Whitmanville Dam) could be retained and thereby permit a two pool system to function. It was contemplated that the pool behind the existing dam would become the recreation pool and the storage between the new dam and the existing dam would become basically the water supply replacement pool. The investigation revealed that it was practical to run a two pool system in both Plans A and B without disturbing the water storage. Present plans envision operating the two pool system by:

a. Satisfying the initial demands for industrial water by a drawdown of 1.5 feet from both pools (i.e., drawdown from El. 826.6 to El. 825.1).

b. Meet supplementary demands with the storage between the two dams. If operated in this fashion, the maximum head differential on the existing dam during the recreation season would be approximately 7 feet for the average year and 13 feet for the years of maximum expected usage of the industrial water. For head differentials of this magnitude the existing dam is considered adequate.

Nookagee Lake. Total storage capacity of 8,400 acre-feet equivalent to 14.6 inches of runoff. The total storage includes allocations of: 700 acre-feet (1.2 inches) for dead storage to serve as a winter pool; 3,000 acre-feet (5.2 inches) for water quality storage; 3,900 acre-feet (6.8 inches) for flood control and 800 acre-feet (1.4 inches) seasonal joint-use storage for flood control and water quality purposes. The full flood control storage of 4,700 acre-feet (8.2 inches) would be provided from September through March. The spring runoff would be stored in part to furnish an added 800 acre-feet to meet water quality requirements. The pool would be lowered by September to reinstate full flood protection.

PLAN B.

Plan B differs and is preferred over Plan A in that the 1,400 acre-feet of recreational storage at Whitmanville, which must be released after Labor Day, will be utilized rather than wasted. This can be accomplished by letting the recreation water releases satisfy the water quality demands for the month of September and, if need be, the demands of October. It is estimated that 800 acre-feet of this water can be so used. Present plans envision discharging the 1,400 acre-feet at a uniform rate such that by 1 November the full flood control storage of 6,700 acre-feet would be available. The flood protection for the period of April thru August would be equivalent to 5.7 inches of runoff plus whatever water supply storage withdrawn. Compensating storage of 1,150 acre-feet for the existing water supply reservoir is similarly included. In Plan B, the Nookagee site would provide year-round flood protection equivalent to 8.2 inches of runoff as well as 3,000 acre-feet of water quality storage. A dead pool storage of 700 acre-feet is retained.

To stabilize the recreation pool at Whitmanville to the fullest extent possible, it is contemplated that all water quality releases for the period of June to September would be made from Nookagee. After Labor Day these releases from Nookagee would be stopped and the water quality demands would be met by Whitmanville. The effect of the industrial water demands at Whitmanville would be the same as for Plan A and a two pool system is similarly contemplated to enhance the recreational potential. The recreational development would be situated in an attractive and semi-rural area behind the existing Westminster Dam. Establishing the maximum recreation pool at El. 826.6 would set the water surface at the same level as the existing reservoir thereby avoiding disturbing an already attractive and interesting shoreline. Exhibit 8, Sheet 1, represents graphically the manner in which the storage for water quality is to be released in order to meet the requirements at Arden Mills. The illustration is presented to show by probability the rates of releases. In all cases, the releases from Nookagee will be first. Sheet 2 of Exhibit 8 illustrates the relationship of the water quality releases with the gaging stations as well as with the water users. Approximately 80% of the water quality releases (Nookagee storage) will enter the North Nashua River at a point below the prime water user. Water quality releases entering at this point will assure that the water will be used primarily for upgrading of the river and will be less subject to interception and usage by industry. This will indirectly assure that the industrial users will continue to operate their system of reservoirs to meet their needs as they are presently doing; which is fundamental to the water quality program.

6. COST ALLOCATION. - Allocation of costs of the multiple-purpose reservoir project to the purposes of flood control, water quality and recreation were made by the separable costs-remaining benefit method. Costs allocated to recreation were apportioned to Federal and non-Federal interests in accordance with the cost sharing policy established by the Federal Water Project Recreation Act (Public Law 89-72) 89th Congress, approved July 9, 1965. Local interests will be required to contribute 50 percent of the separable project first costs attributable to recreation and fish and wildlife enhancement. Fifty percent of such separable project costs is presently estimated to be $200,000. Flood control and water quality benefits which would be realized from the selected plan are widespread and their allocated costs are, therefore, considered entirely Federal.

Results of the cost allocation indicate that there is a favorable benefit/cost ratio for all project purposes at both sites (see Exhibit 9).

Comparison of the annual benefits of the altered projects with the as-authorized projects is as follows:

Whitmanville	Authorized	Altered
Flood Control	$464,000	$1,352,000
Water Supply	58,000	-
Recreation	-	125,000
Water Quality	-	190,000
Total	$522,000	$1,667,000

Nookagee		
Flood Control	$357,000	$ 677,000
Water Supply	130,000	-
Recreation	90,000	-
Water Quality	-	373,000
Total	$577,000	$1,050,000

The increases in annual flood control benefits in the period 1962 through 1970 are attributed to the following:

(1) an approximate 60 percent escalation in prices since 1962.

(2) growth in the urban area of the North Nashua River during the 1962-1970 period, and

(3) revised projected growth over the project life based on the past eight years.

Water quality benefits have been equated to the annual cost of a single-purpose dam providing equivalent water quality storage. This would be the most likely alternative in the absence of the Federal project.

Recreation benefits are based on annual visitation of 100,000 at $1.25 per day.

7. COORDINATION. - In the studies leading to the recommended projects alterations, consultation with local, state and other Federal agencies has been pursued. Close coordination in particular with the Department of Interior, Federal Water Quality Administration, Northeast Region, has been maintained in resolving problems relating to low flow augmentation for water quality. Users of the existing industrial water at Westminster have voiced their approval of the alterations and have expressed their willingness to cooperate. They have shown an understanding for the need for water quality improvements and have expressed their willingness to continue to operate their system of reservoirs as they are presently doing.

Coordination on a regional level has been established with the Montachusett Regional Planning Commission as suggested by Mayor Flynn in his letter dated 9 September 1969 (Exhibit 2).

Recreational development of the lakes has been explored with the Massachusetts Department of Natural Resources. This Department has concurred that the Whitmanville site offers greater recreational potential than the Nookagee site and is actively supporting and assisting in the recreation planning. The M. D. N. R. has expressed a willingness to provide the necessary contributions required for recreational development and a letter of intent will be requested immediately upon approval of reformulation.

8. CONCLUSION. - It is concluded that the most efficient way to implement development of the water resource plan, as previously authorized by Congress, is by construction of a multi-purpose dam and lake at Whitmanville, and a dual-purpose project at Nookagee. The project purposes for Whitmanville would include flood control, water quality, and recreation as well as replacement of the existing industrial water. At Nookagee, the project purposes would include flood control and water quality. The water quality aspects are not substitutions for water supplies, but rather, fulfillment of the assurance made by the Chief of Engineers to HEW prior to authorization (Exhibit 4). Such development would be compatible with the intent of authorization and a valuable part of the comprehensive plans of the North Nashua River Basin as contained in Senate Document No. 113. The net result of the alterations to the projects can be summarized as: (a) removal of the additional industrial water supplies, (b) inclusion of water quality, and (c) transfer of recreation from Nookagee to Whitmanville. The sites of the projects as well as the height of dams and spillways remain the same as contained in the authorizing document.

9. RECOMMENDATIONS. - The Division Engineer recommends that the authorized projects of Whitmanville and Nookagee be modified to reflect the desires of the local interests such that the project purposes at Whitmanville would be flood control, water quality and recreation, and at Nookagee the purposes would be flood control and water quality essentially as outlined in this report as Plan B. Estimated total initial costs are $6,250,000 and $8,400,000, respectively. At Whitmanville, $200,000 would be reimbursable by local interests under the provisions of the Federal Water Project Recreation Act of 1965. The estimated annual cost at Whitmanville for maintenance, operation and major replacements for the project is $68,000 of which $50,000 would be a Federal responsibility.

He further recommends that the assurances to be furnished by the non-Federal interests be modified for the Whitmanville and Nookagee projects such that responsible non-Federal interests are required to give assurances satisfactory to the Secretary of the Army that they will:

a. In accordance with the Federal Water Project Recreation Act of 1965:

(1) Administer project land and water areas for recreation and fish and wildlife enhancement;

(2) Pay, contribute in kind, or repay (which may be through user fees) with interest, one-half of the separable first costs of the reservoir projects allocated to recreation and fish and wildlife enhancement, the amount involved being currently estimated as follows:

Reservoir	Amount
Whitmanville	$200,000

(3) Bear all costs of operation, maintenance, and replacement of recreation and fish and wildlife lands and facilities, the amounts involved being currently estimated on an average annual basis as follows:

Reservoir	Amount
Whitmanville	$18,000

Provided that the sizing and responsibility for development, operation, maintenance, and replacement of the recreation and fish and wildlife enhancement features of the reservoirs may be modified in accordance with the alternative provided in the proposed Federal Water Project Recreation Act cited above, depending upon the intentions of local interests regarding participation in the costs of these features at the time of reservoir construction and subsequent thereto, and that appropriate adjustments reflecting such modifications may be made in the allocation of costs to other project purposes;

b. Protect channels downstream of the reservoirs from encroachments which would adversely affect operation of the system;

c. Hold and save the United States free from all damages due to water-rights claims resulting from construction and operation of the reservoirs;

d. Exercise to the full extent of their legal capability, control, against removal of water in the basin which will affect the reservoirs water quality storage and the development of dependable stream regulations; and

e. Exercise, to the full extent of their legal capability, control against removal of stream flow made available by reservoir storage for water quality.

PERTINENT DATA
PROJECTS AS AUTHORIZED BY 89th CONGRESS

Feature	Whitmanville	Nookagee
Purpose (1)	FC & WS	FC, WS & R
Drainage Area (Net)	17.5	11.0
Elevations (ft., msl)		
Top of Dam	860	848
Flood Control Pool		
(spillway crest)	845	835
Surface Area, Acres	420	295
Water Supply Pool		
(spillway crest)	824	815
Surface Area, Acres	200	170
Recreation Pool		
(spillway crest min.)	-	790
Surface Area, (min.) Acres	-	50
Dam		
Type of Dam	Earth Fill	Earth Fill
Length of Dam, ft.	1,470	2,150
Max. Height, ft.	76	106
Top Width, ft.	20	25
Spillway		
Type	Chute	Side Chan.
Location	Lf. Abt.	Lf. Abt.
Crest Length, ft.	200	205
Design Discharge, cfs	25,200	15,900
Outlet Conduits		
Flood Control		
Length	26	200
Inside Diameter	4' x 3'	48"
Water Supply		
Length	310'	470'
Inside Diameter	24"	24"
Reservoir Storage		
Flood Control, ac.ft.	6,700	4,700
Water Supply, ac.ft.	2,650	2,600
Recreation, ac.ft.	-	800
Flood Control, runoff	7.2"	8.0"
Water Supply, runoff	2.8"	4.4"
Recreation, runoff	-	1.4"

(1) FC = Flood Control; WS = Water Supply; R = Recreation

EXHIBIT 1

OFFICE OF THE MAYOR

FITCHBURG, MASSACHUSETTS
01420

WILLIAM G. FLYNN
MAYOR

THOMAS J. CONRY, JR.
ADMINISTRATIVE ASSISTANT

MRS. NANCY A. MAYNARD
SECRETARY

September 9, 1969

Colonel Frank P. Bane
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Bane

In reply to your recent request for a determination on the part of the City of Fitchburg as to what course of action the city intends to take concerning participation in the Whitmanville Dam Project. This is to advise you that the City of Fitchburg does not intend to participate in the construction of a Reservoir Storage Basin. This determination has been made as a result of conferences with the Commissioner of Public Works, Superintendent of Water and representatives of our local industries.

I am enclosing with this letter, for your information, copies of letters I have received from the Commissioner of Public Works, Superintendent of Water and Mr. Edward A. Newcomb of Weyerhaeuser Company.

I would suggest that before the Corps of Engineers makes the final determination relative to this project, that a letter and formal presentation be made to the Montachusett Regional Planning District Board so that this entire matter may be looked at from a Regional standpoint. The Chairman of this Planning Board is Mr. Leon J. Boudreau, P.O. Box 480, Fitchburg, Massachusetts 01420.

If I can be of additional assistance to you please feel free to call my office.

Very truly yours,

William G. Flynn

William G. Flynn
Mayor

WGF/nm

EXHIBIT 2

CITY OF FITCHBURG
DEPARTMENT of PUBLIC WORKS
City Hall, 718 Main Street
FITCHBURG, MASSACHUSETTS 01420

ENGINEERING
HIGHWAYS
SEWERS
SEWAGE DISPOSAL
STREET LIGHTING
WATER SUPPLY
REFUSE COLLECTION

GEORGE J. LANIDES
COMMISSIONER AND CITY ENGINEER

September 4, 1969

Honorable William G. Flynn
Mayor, City of Fitchburg

Dear Mayor Flynn:

In reply to your letter of August 26, 1969 regarding the three reservoir projects as proposed by the U.S.Corps, Army Engineers in the Nashua River Basin, namely Whitmanville, Nookagee and Manoosnoc sites, it is my opinion that the City of Fitchburg should not participate in financing these projects because of the high outlay of funds for construction and additional funds to make these waters suitable for drinking purposes.

The proportionate cost as outlined in the 1965 report of the U.S. Corps is 3.13 million dollars which is to be borne by local interests for the Whitmanville and Nookagee Dams. To this must be added 1 million dollars because the construction cost have risen over 30% since 1965 making the construction expenditure 4.1 million dollars.

Because the quality of water contained in these basins is not suitable for drinking purposes, the City would have to construct filtration plants at each site at an approximate expenditure of 1 million dollars.

The construction of transmission lines, chlorination plants and other incidentals would add another one half million dollars.

The total financial outlay would amount to nearly 5.5 million dollars before these waters were suitable for drinking purposes and adding the cost of maintenance would make it prohibitive for the City to undertake this project at this time.

I also enclose recommendations as outlined by Mr. J. A. Provencial, Superintendent of Water.

Yours truly,

George J. Lanides
Commissioner of Public Works

RECEIVED
SEP 4 1969
MAYOR'S OFFICE

CJL/mom

City of Fitchburg
Massachusetts
Water Division

OFFICE
CITY HALL
TELEPHONE 345-[illegible]

SHOP
79 RIVER STREET
TELEPHONE 345-[illegible]

J. ANDRE PROVENCIAL
SUPERINTENDENT AND REGISTRAR

September 2, 1969

Mr. George J. Lanides
Commissioner of Public Works
City Hall
Fitchburg, Massachusetts

Dear Mr. Lanides: (re: Whitmanville Dam)

I do not believe the City of Fitchburg should finance part of this dam, and charge it to the Fitchburg potable water supply at this time. The quality of this water is suitable only for industrial water. To use this water in the Fitchburg potable water supply would mean building a filtration plant, which would have a high cost. The cost of operating and maintaining a filter plant, are also prohibitive.

I believe we should develop all the resources we now have, (Dickford and Whittuck), before we attempt to develop any water supply, where a filter plant will be needed.

It is my opinion, that if industry can use this water, and are willing to finance dam construction, that the City of Fitchburg should co-operate wherever possible.

Very truly yours,

J. André Provencial

J. André Provencial
Superintendent & Registrar

JAP/j

Weyerhaeuser Company
Paper Division

Box 601 • Fitchburg, Massachusetts 01420
Telephone: 617-343-3061

August 22, 1969

The Honorable William G. Flynn
Mayor of the City of Fitchburg
Fitchburg, Massachusetts 01420

Dear Mayor Flynn:

The Nashua River Reservoir Co. wishes to go on record as being in favor of more water storage capacity on the Whitman River, but we cannot justify any financial outlay for such at the present time.

Since the severe drought of the years 1964-65-66, the companies represented by the Nashua River Reservoir Company have sharply reduced their consumption of water, and they have plans to increase the efficiency of water use still further. Without any change, the Westminster reservoir currently provides, and can be expected to continue to provide, adequate supply of water in conjunction with our other reservoirs. We understand the proposed Whitmanville flood control project will eliminate the Westminster reservoir. If Westminster reservoir is eliminated, it is imperative that the water storage be replaced in kind (quantity and quality).

The Nashua River Reservoir Co. feels that it is entitled to as much water storage volume, and in like quality, in the proposed Whitmanville flood control project as is currently available in its existing Westminster reservoir. The company further feels that it should maintain control of that volume to be used when and how it deems appropriate as is the case today with Westminster reservoir.

For your information, the Nashua River Reservoir Co. is comprised of the following: Weyerhaeuser Co., Fitchburg Paper Co., and Falulah Paper Co.

Very truly yours,

Edward A. Newcomb, President
NASHUA RIVER RESERVOIR COMPANY

OFFICE OF THE MAYOR
FITCHBURG, MASSACHUSETTS
01420

WILLIAM G. FLYNN
MAYOR

THOMAS J. CONRY, JR.
ADMINISTRATIVE ASSISTANT

MRS. NANCY A. MAYNARD
SECRETARY

November 25, 1969

Senator Edward Kennedy
Senate Office Building
Washington, D. C.

Dear Senator Kennedy

During your recent visit to the Fitchburg area to inspect the pollution of the Nashua River, you asked that I write to you relative to the need to include sufficient water storage capacity for low flow augmentation of the Nashua River as part of the Army Corps of Engineers North Nashua River Flood Control Project.

It is my understanding that the Corps of Engineers is prepared to begin the design phase of the project pending allocation of design funds. However, since this project (by city choice) will not include domestic water supply, it appears that it might have lost a priority rating.

The Whitmanville, Nookagee, and Monoosnoc Dams are vitally needed as flood control measures for the North Nashua River, and inclusion of sufficient storage capacity to assure water for low flow periods is critical to the effectiveness of the entire pollution abatement program.

I would suggest that for more detailed information on this project your office contact:

Colonel Frank P. Bane, Division Engineer
New England Division
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

EXHIBIT 3

Your continued interest and strongest intercessions are important for the success of the Nashua River Clean-Up Program.

With every good wish, I remain

Very truly yours

William G. Flynn

William G. Flynn
Mayor

WGF/nm

cc: Alan E. Rimer
George Lanides
Marian Stoddart

COMMENTS OF THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

January 25, 1966

Lieutenant General William F. Cassidy
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Cassidy:

This is in reply to your letter of July 14, 1965, requesting comments on the Survey Report of the North Nashua River and Tributaries, Merrimack River Basin, Massachusetts.

The North Nashua River basin is included in the water pollution control interstate enforcement action covering the Merrimack River basin. Studies are now under way to determine the level of waste treatment to be required of industries and municipalities in the basin. Until these determinations are made, and a schedule for abatement set up, we are unable to make firm projections of needs for storage for water quality control.

Preliminary studies by the Federal Water Pollution Control Administration upon which discussion of water quality conditions in the North Nashua River Basin survey report were based indicate that presently available treatment methods cannot alone control the polluted condition of the stream. While the regulation potential of project sites are indicated in your report to be inadequate to meet the entire needs for both municipal and industrial water supply and preliminary projections of flow regulation for water quality control, even partial provision for stream flow regulation could result in substantial quality improvement with attendant benefits within the study area. For this reason, it is our view that authority to include water quality control as a project purpose should be sought at this time and that further study should be given to the storage needed and the benefits to be derived from flow regulation as an interim and/or partial means of meeting water quality control needs in the North Nashua River.

Our Boston Regional Office will keep the District Engineer informed of progress on the Merrimack studies so that adequate consideration can be given to flow regulation needs during further planning for the proposed project.

xx

EXHIBIT 4

The opportunity to review the Report is appreciated. We will provide further information on water quality control needs and benefits as the above mentioned studies are carried out.

Sincerely yours,

Keith S. Krause

Keith S. Krause
Chief, Technical Services Program

LETTER TO THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20315

IN REPLY REFER TO
ENGCW-PD

7 February 1966

Mr. Keith Krause
Chief, Technical Services Program
Federal Water Pollution Control
Administration
Department of Health, Education
and Welfare

Dear Mr. Krause:

This is in reply to your recent letter commenting on the proposed report of the Chief of Engineers, on North Nashua River and Tributaries, Merrimack River Basin, Massachusetts.

If the project is authorized by Congress, you may be assured that prior to initiation of construction, studies will be made concerning the needs for storage for water quality control. This matter will be fully coordinated with the Federal Water Pollution Control Administration during the planning stage.

Copies of your letter and this reply will accompany my report when it is submitted to the Congress.

Sincerely yours,

(Signed)

WILLIAM F. CASSIDY
Lieutenant General, USA
Chief of Engineers

C. STREAMFLOW REGULATION FOR WATER QUALITY CONTROL

Projected treated residual waste loads for the years 2020 and 2070 in combination with various flow conditions in the North Nashua River have been analyzed with respect to dissolved oxygen content since oxygen content is a generally accepted indicator of water quality. The analysis indicates that even with an average of 90 percent reduction of the oxygen demanding wastes, additional streamflow augmentation in the North Nashua River will be necessary to maintain a dissolved oxygen content of 5 mg/l required by the Massachusetts water quality standards.

The calculation of waste assimilative capacity employed the Streeter-Phelps equation for oxygen sag, and the rate constants of deoxygenation (K_1) and reaeration (K_2) were based on data obtained from river samples collected and analyzed by the Federal Water Pollution Control Administration's Merrimack River Project. As dissolved oxygen contents are highly dependent on temperature, calculations were made for river water temperatures of 20°C, 25°C, and 30°C.

On the basis of the calculations, it is estimated that the following minimum daily flows, as measured at the Leominster gage, are required to maintain dissolved oxygen levels above 5 mg/l even after a high degree of waste treatment is provided at all pollution sources.

EXHIBIT 5 SH. 1

TABLE IV

MINIMUM FLOW REQUIREMENTS FOR
WATER QUALITY CONTROL

(Measured at Leominster Gage, drainage area equals 107 sq.mi.)

2020 WASTE LOAD

Month	Required Flow (cfs)	Observed Minimum Mean Monthly Flow of Record (cfs)
May	30	85
June	40	64
July	60	43
August	60	38
September	40	38
October	30	39
November	30	44

REVISED
SEE
LETTER
31 OCT. 69

2070 WASTE LOAD

Month	Required Flow (cfs)	Observed Minimum Mean Monthly Flow of Record (cfs)
May	50	85
June	50	64
July	80	43
August	80	38
September	50	38
October	50	39
November	40	44

EXHIBIT 5 SH. 2

UNITED STATES
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
New England Basins Office
240 Highland Avenue
Needham Heights, Massachusetts 02194

October 31, 1969

Mr. John W. Leslie
Chief, Engineering Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

Reference is made to our report entitled "Water Quality Control Study, North Nashua River Basin, Massachusetts" which was transmitted to you on April 17, 1968.

Since completing the report, additional studies have been made in conjunction with your staff which show that flow requirements for water quality control should be shown at an upstream location to help in the design of the Whitmanville and Nookagee reservoirs. Accordingly our calculations have been revised and also updated in view of new waste load and waste flow data developed as part of recent engineering studies done for the City of Fitchburg.

For reservoir project formulation, the river flows given below will provide significant benefits for water quality control purposes and should be used. Benefits shown in Table VIII of the referenced report of $186,000 are considered conservative because they do not include intangible benefits. The flows are the total flow in the river as measured in the vicinity of the proposed West Fitchburg treatment plant. They include both plant waste flows and the river flow, and are derived on the basis of estimated 2020 loading conditions.

Month	Total River Flow (CFS)
May	23
June	31
July	40
August	40
September	31
October	23

EXHIBIT 5 SH. 3

Releases from both new and existing storage will be required to meet this flow regime. Assurance that operation of the existing reservoirs will be compatible and coordinated with the operation of any new Federal storage is therefore essential if the water quality benefits are to be realized.

FOR THE REGIONAL DIRECTOR:

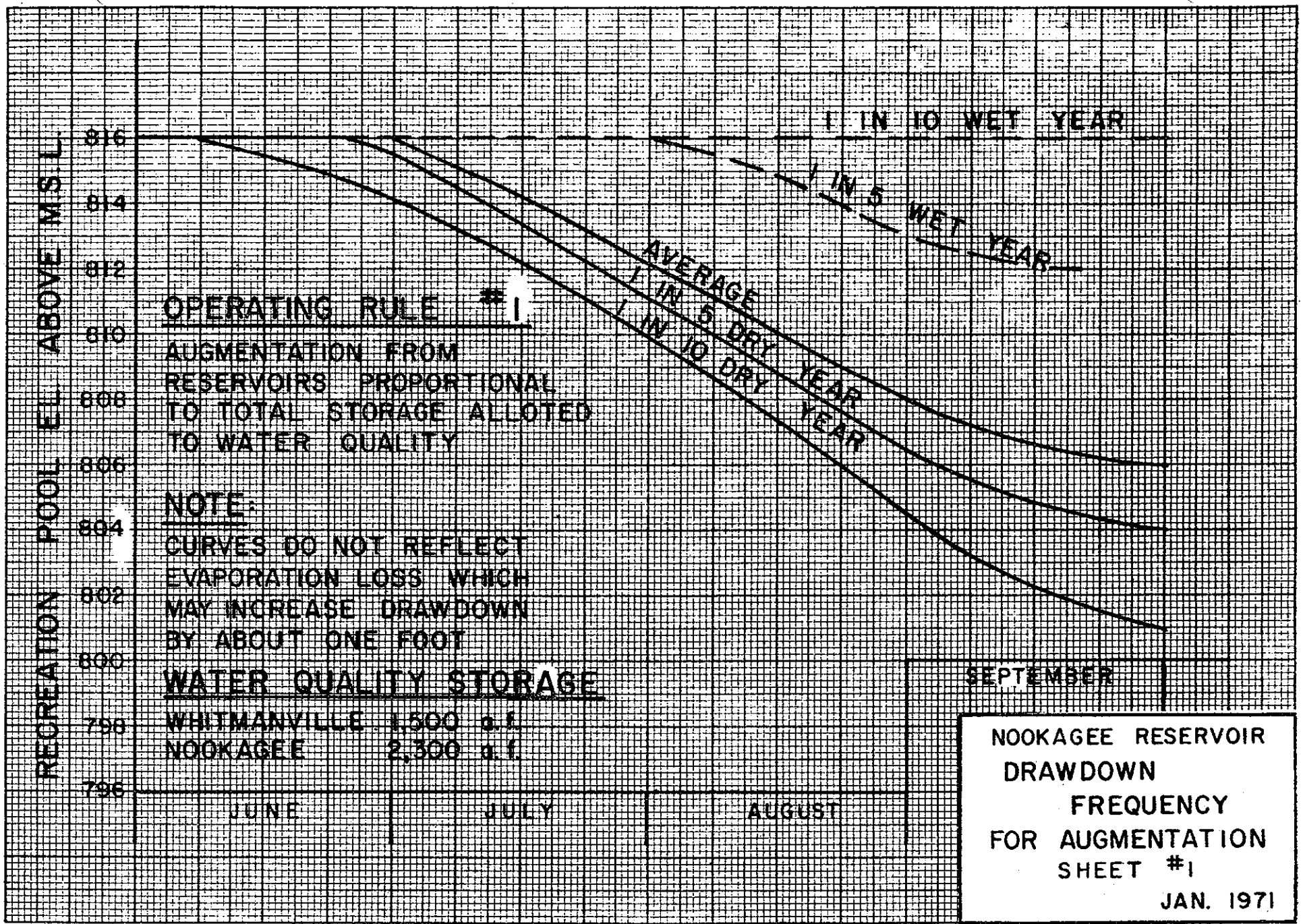
Sincerely yours,

Bart Hague

Bart Hague
Chief of Planning

EXHIBIT 5 SH. 4

KEUFFEL & ESSER CO.



NOOKAGEE RESERVOIR
DRAWDOWN
FREQUENCY
FOR AUGMENTATION
SHEET #1
JAN. 1971

EXHIBIT 6 SH. 1

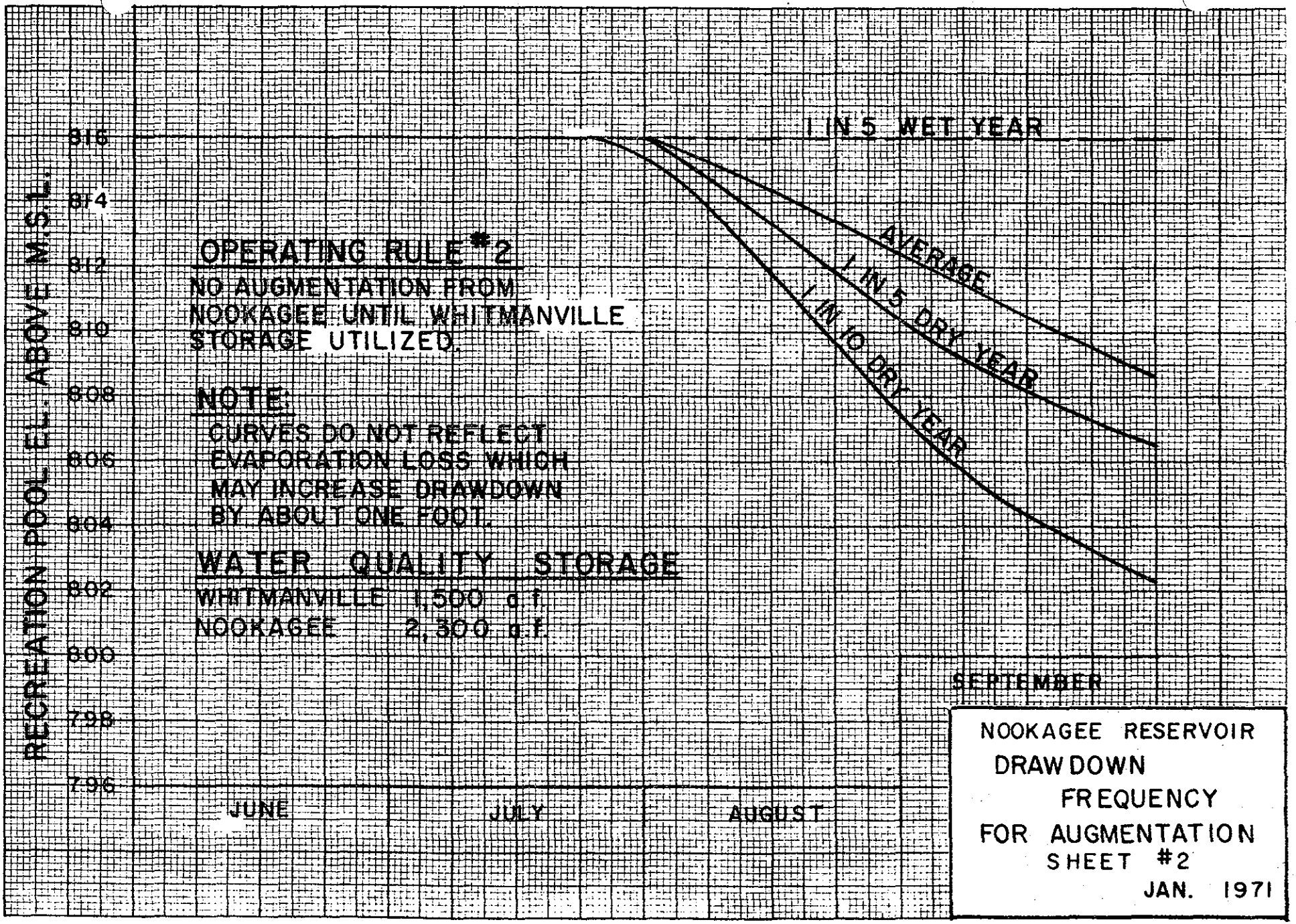
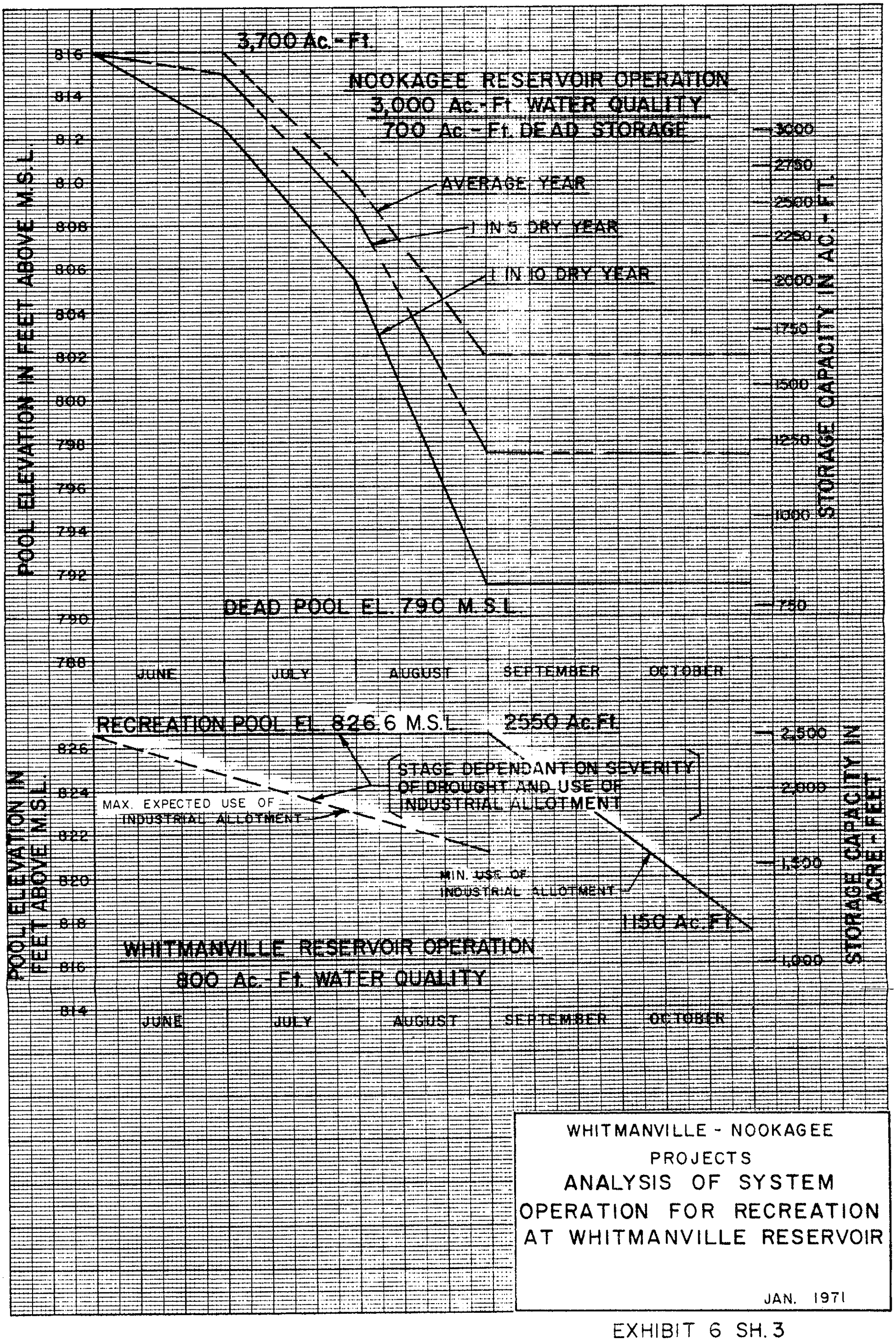


EXHIBIT 6 SH. 2



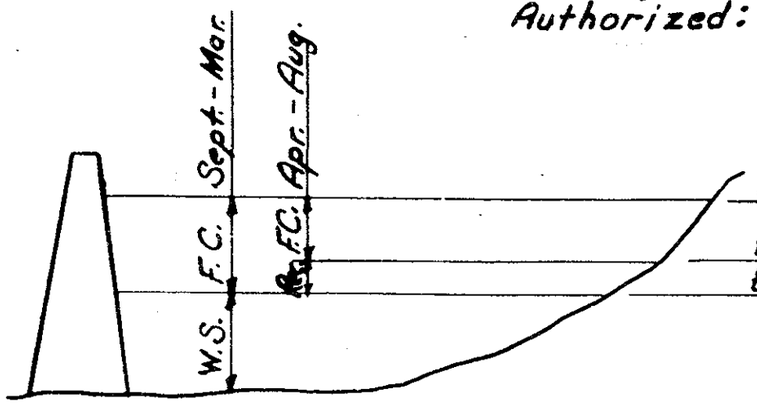
WHITMANVILLE - NOOKAGEE
PROJECTS
ANALYSIS OF SYSTEM
OPERATION FOR RECREATION
AT WHITMANVILLE RESERVOIR

JAN. 1971

EXHIBIT 6 SH. 3

WHITMANVILLE

Drainage Area 17.5 sq. mi.
Authorized: F.C. 6,700 A.F. 7.2" R.O.
W.S. 2,650 2.8"
9,350 A.F. 10.0" R.O.

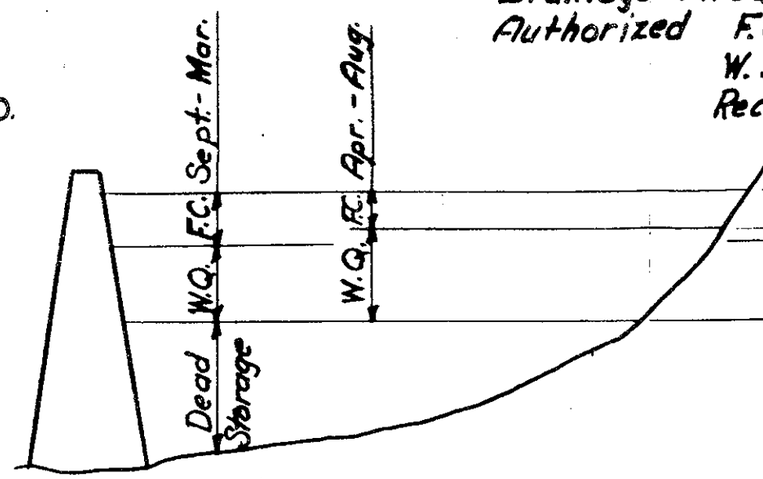


	R.O.	A.F.
El. 845.0		
El. 826.6	5.7"	5,300
El. 817.5	1.5	1,400
	1.2	1,150
	8.4"	7,850 *

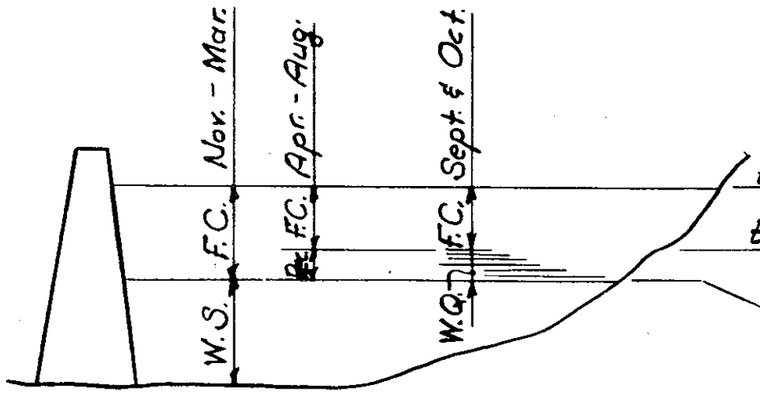
PLAN A

NOOKAGEE

Drainage Area 11.0 Sq. mi.
Authorized F.C. 4,700 A.F. 8" R.O.
W.S. 2,600 4.4"
Rec. 800 1.4"
8,100 13.8"

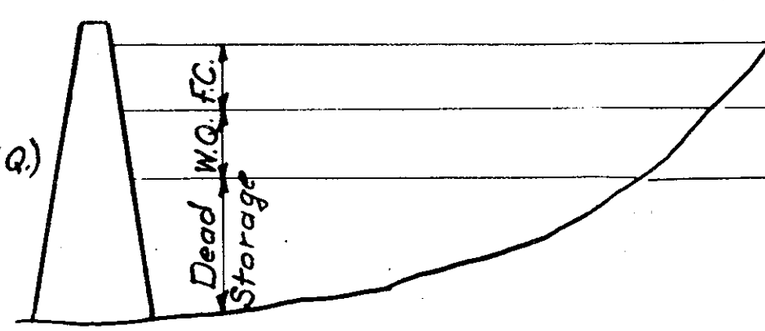


	R.O.	A.F.
El. 835.0		
El. 820.0	6.8"	3,900
El. 816.0	1.4	800
	5.2	3,000
El. 790.0		
	1.2	700
	14.6"	8,400 *



	R.O.	A.F
El. 845.0		
El. 826.6	5.7"	5,300
El. 817.5	0.65	600
	0.85	800 (W.Q.)
	1.2	1,150
	8.4"	7,850 *

PLAN B
(RECOMMENDED)



	R.O.	A.F.
El. 835.0		
El. 816.0	8.2"	4,700
El. 790.0	5.2	3,000
	1.2	700
	14.6"	8,400 *

LEGEND

A.F. = Acre Feet
R.O. = Run Off
Rec. = Recreation
F.C. = Flood Control
W.Q. = Water Quality
W.S. = Water Supply (Reservoir Company)

* Based upon more accurate mapping.

EXHIBIT NO. 7

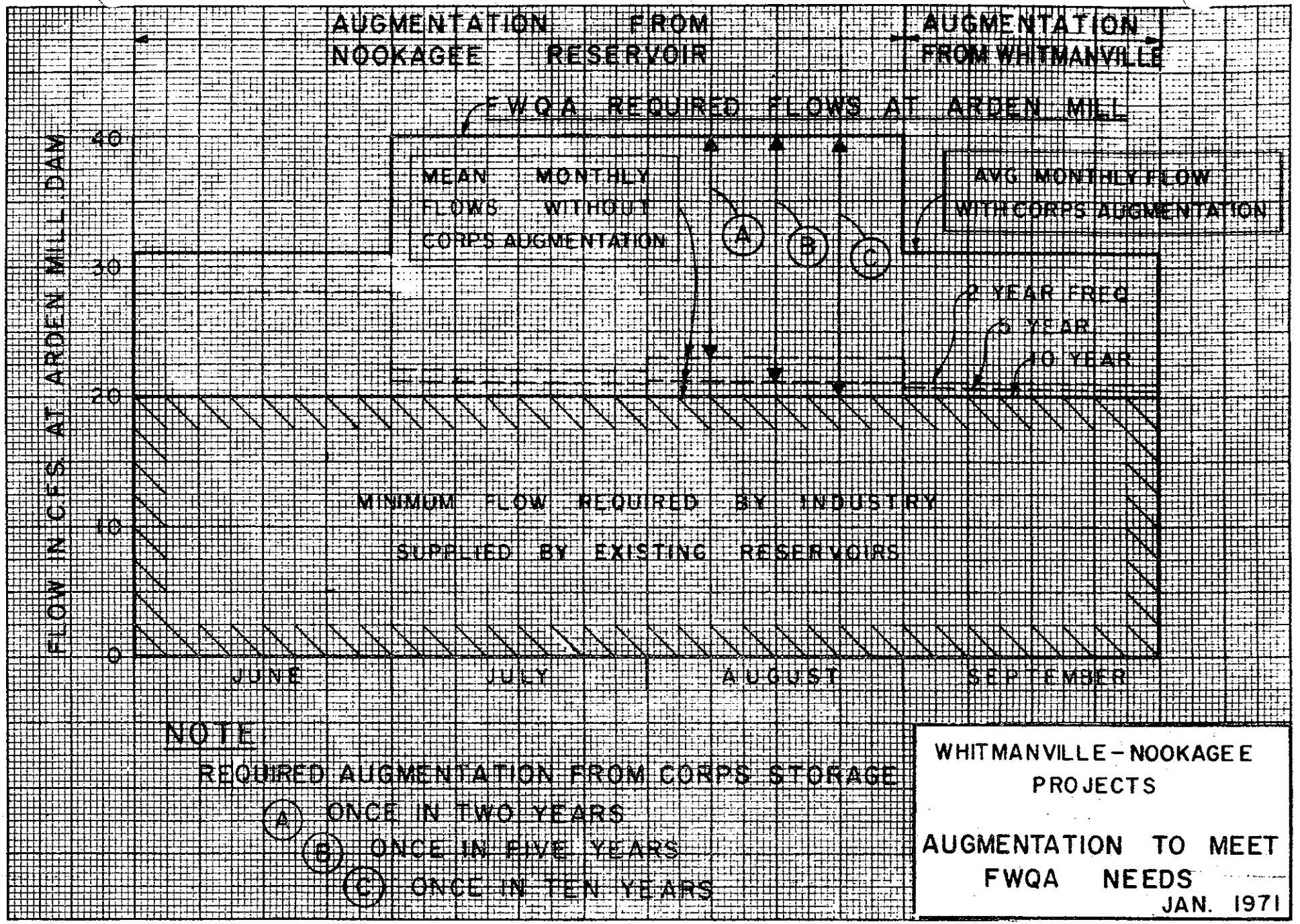


EXHIBIT 8 SH. 1

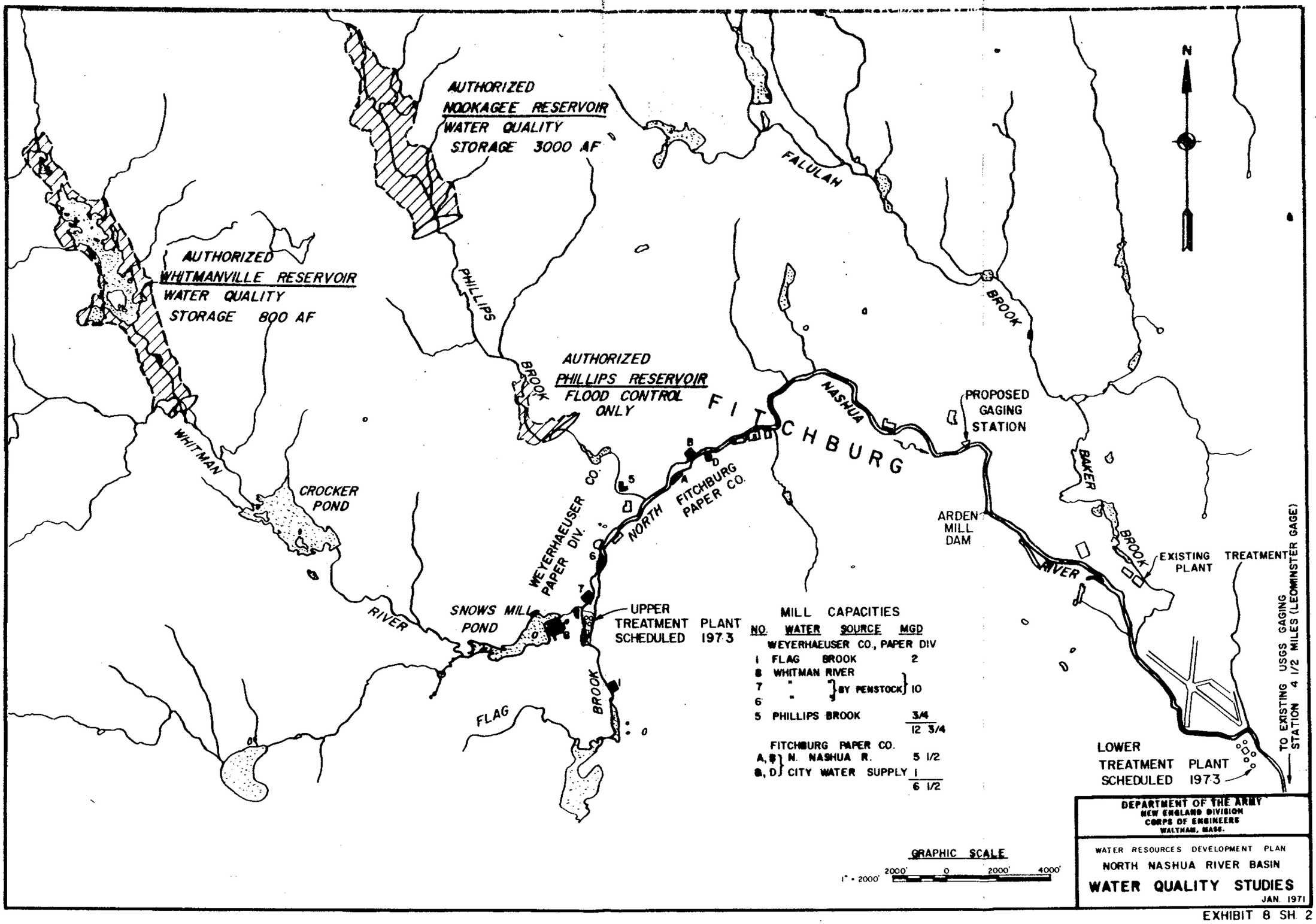


EXHIBIT 8 SH. 2

TABLE W-1

WHITMANVILLE DAM AND LAKE
COST ALLOCATION STUDIES

PERTINENT DATA

Item	Unit	Multiple Purpose Project	ALTERNATIVE SINGLE-PURPOSE PROJECTS		
			Flood Control	Water Quality	Recreation
General					
Location		Whitman River, Westminster, Mass., 5 miles west of the center of Fitchburg	Same as Multiple-Purpose	Area from Multiple-Purpose to Existing Westminster Reservoir	Same as Multiple-Purpose
Drainage Area	Sq. mi.	17.5	17.5	17.5	17.5
RESERVOIR					
Elevation:					
Top of flood control pool	Ft. msl	845	845		
*Top of water supply pool	"	817.5			
Top of water quality pool	"	822.5		814	
Top of recreational pool	"	826.6			826.6
Stream bed	"	784	784	784	784
Reservoir Area:					
Top of flood control pool	Ac.	380	380		
*Top of water supply pool	"	100			
Top of water quality pool	"	150		40	
Top of recreational pool	"	200			200
Storage Capacity:					
Total	Ac. Ft.	7,850			
Flood control	"	6,700	6,700		
*Water Supply	"	1,150			
** Water Quality	"	800		800	
** Recreation	"	1,400			1,400
DAM AND APPURTENANCES					
Dam:					
Type		Rolled earth fill with stone slope protection	Same as Multiple-Purpose	Same as Multiple-Purpose	Same as Multiple-Purpose
Elevation, top of dam	Ft. msl	860	860	824	837
Length	Ft.	1,470	1,470	1,250	1,300
Height	"	76	76	40	53
Width, top of dam	"	25	25	25	25
Spillway:					
Type		Uncontrolled	Uncontrolled	Uncontrolled	Uncontrolled
Elevation of crest	Ft. msl	845	845	814	826.6
Outlet Conduits:					
Type		Gate controlled rectangular and gate controlled pipe through dam	Uncontrolled rectangular through spillway monoliths	Gate controlled pipe through dam	Gate controlled pipe through dam
Number		2	1	1	1
Dimensions	Ft.	4'x3' and 2' diameter	4'x3'	2' diameter	2' diameter
Sluice Gates:					
Number		3	0	3	2
Size	Ft.	2'x2' (2) 4'x7'		2'x2' (2) 4'x7'	2'x2' (2)

* Replacement of existing water supply.
** Seasonal encroachment on flood control storage.

EXHIBIT 9 SH. 1

TABLE W-2

ALLOCATION OF ANNUAL CHARGES
(in $1,000 at 1970 Price Level)
WHITMANVILLE DAM AND LAKE, MASSACHUSETTS

	MULTIPLE-PURPOSE PROJECT					ALTERNATIVE TWO-PURPOSE PROJECTS			ALTERNATIVE SINGLE-PURPOSE PROJECTS		
	Specific Costs			JOINT USE COSTS	TOTAL	REC. & W.Q.	F.C. & REC.	F.C. & W.Q.	F.C.	W.Q.	REC.
	F.C.	W.Q.	REC.								
ELEVATIONS (msl)											
Top of Dam					860	837	860	860	860	824	837
Spillway Crest					845	826.6	845	845	845	814	826.6
Top of F. C. Pool					845	--	845	845	845	--	--
Top of Rec. Pool					826.6	826.6	826.6	--	--	--	826.6
Top of W.Q. Pool					826.6	826.6	--	822.5	--	814	--
Minimum or Winter Pool					817.5	826.6	817.5	817.5	817.5	814	817.5
PROJECT FIRST COSTS											
Lands and Damages				$ 940	$ 940	$ 320	$ 940	$ 940	$ 940	$ 170	$ 320
Relocations				830	830	250	830	830	830	170	250
Reservoir				80	80	80	80	70	60	40	70
Dam & Appurtenant Facilities		30		2,890	2,920	2,345	2,880	2,920	2,880	2,090	2,315
Bldgs., Grounds & Utilities				70	70	40	70	70	60	30	40
Permanent Operating Equipment				40	40	30	40	40	40	20	30
Recreation Facilities			300	0	300	300	300				300
Engineering & Design				640	640	500	650	580	590	420	500
Supervision & Administration				430	430	335	410	400	400	260	325
TOTAL PROJECT FIRST COSTS		$ 30	$ 300	$5,920	$6,250	$4,200	$6,200	$5,850	$5,800	$3,200	$4,150
INVESTMENT											
Construction Expenditure		30	300	5,920	6,250	4,200	6,200	5,850	5,800	3,200	4,150
Interest During Construction		2	15	303	320	215	318	300	297	164	213
Present Worth of Future Addns. for Rec.				0	0	0	0	0	0	0	0
INVESTMENT		$ 32	$ 315	$6,223	$6,570	$4,415	$6,518	$6,150	$6,097	$3,364	$4,363
ANNUAL CHARGES											
Interest		2	16	319	337	226	334	315	312	172	224
Amortization		0	0	2	2	2	2	2	2	1	2
Operation & Maintenance		5	16	41	62	38	57	46	24	15	30
Major Replacements			2	4	6	4	5	4	3	2	3
Net Loss to Fish & Wildlife				0	0	0	0	0	0	0	0
TOTAL ANNUAL CHARGES		$ 7	$ 34	$ 366	$ 407	$ 270	$ 398	$ 367	$ 341	$ 190	$ 259

ALLOCATION OF ANNUAL CHARGES

	F.C.	W.Q.	REC.	TOTAL
Benefits	$ 1,352	$ 190	$ 125	$ 1,667
Alternative Project Cost	341	190	259	790
Benefits Limited by Alternative Cost	341	190	125	656
Separable Cost	137	9	40	186
Remaining Benefits	204	181	85	470
Allocated Joint Costs	96	85	40	221
ALLOCATION OF ANNUAL CHARGES	$ 233	$ 94	$ 80	$ 407

EXHIBIT 9 SH. 2

TABLE W-3

ALLOCATION OF CONSTRUCTION COST
(in $1,000 at 1970 Price Level)
WHITMANVILLE DAM AND LAKE, MASSACHUSETTS

	Flood Control	W. Q.	Rec.	Total
ALLOCATION OF ANNUAL CHARGES (From Table W-2)	$ 233	$ 94	$ 80	$ 407
ALLOCATION OF OPERATION & MAINTENANCE				
Separable Costs	24	5	16	45
Allocated Joint Costs	7	7	3	17
Total Allocation, O & M	31	12	19	62
Specific Costs	0	5	16	21
Allocation of Joint-Use Costs	31	7	3	41
Ratio of Allocation of Joint-Use O&M	75.6%	17.1%	7.3%	100%
ALLOCATION OF MAJOR REPLACEMENTS				
Separable Costs	2	1	2	5
Allocated Joint Costs	1	0	0	1
Total Allocation, Major Replacements	3	1	2	6
ALLOCATION OF INVESTMENT				
Annual Investment	199	81	59	339
Ratio of Annual Investment	58.7%	23.9%	17.4%	100%
Allocated Investment	3,857	1,570	1,143	6,570
Present Worth of Future Additions for Recreation	0	0	0	0
Initial Investment	3,857	1,570	1,143	6,570
ALLOCATION OF CONSTRUCTION EXPENDITURES				
Specific Investment	0	32	315	347
Investment in Joint-Use Facilities	3,857	1,538	828	6,223
Construction Expenditures in Joint-Use Facilities	3,670	1,462	788	5,920
Percent of Construction Expenditures in Joint-Use Facilities	62.0%	24.7%	13.3%	100%
Construction Expenditures in Specific Facilities	0	30	300	330
Total Construction Expenditures	$3,670	$1,492	$1,088	$6,250
SUMMARY				
Total Construction Expenditures	$3,670	$1,492	$1,088	$6,250
Annual Costs	233	94	80	407
Annual Benefits	1,352	190	125	1,667
Benefit/Cost Ratio	5.8	2.0	1.6	4.1

EXHIBIT 9 SH. 3

TABLE N-1

NOOKAGEE DAM AND LAKE
COST ALLOCATION STUDIES

PERTINENT DATA

Item	Unit	Multiple Purpose Project	ALTERNATIVE SINGLE-PURPOSE PROJECTS Flood Control	Water Quality
General				
Location		Phillips Brook, Westminster, Mass.	Same as multiple-purpose	Same as multiple-purpose
Drainage Area	Sq. mi.	11	11	11
RESERVOIR				
Elevation:				
Top of flood control pool	Ft. msl	835	821	
Top of water quality pool	"	816		816
Top of conservation pool	"	790		
Stream bed	"	742	742	742
Reservoir Area:				
Top of flood control pool	Acres	316	222	
Top of water quality pool	"	190		190
Top of conservation pool	"	50		
Storage Capacity:				
Total	Ac. Ft.	8,400	4,700	3,700
Flood Control	"	4,700	4,700	
Water Quality	"	3,000		3,000
Conservation (deal pool)	"	700		
DAM AND APPURTENANCES				
Dam:				
Type		Rolled earth fill with rock slope protection	Same as multiple-purpose	Same as multiple-purpose
Elevation, top of dam	Ft. msl	848	834	826
Length	Ft.	2,070	1,910	1,860
Height	"	106	92	84
Width, top of dam	"	25	25	25
Spillway:				
Type		Uncontrolled	Uncon.	Uncon.
Elevation of crest	Ft. msl	835	821	816
Outlet Conduits:				
Type		Gate controlled pipes through dam	Uncontrolled pipe through dam	Gate con. pipe through dam
Number		2	1	1
Dimensions (pipe diameters)	Inches	48 and 24	48	24
Sluice Gates				
Number		3	0	3
Size	Ft.	2'x2' (2) 4'x7'		2'x2' (2) 4'x7'

EXHIBIT 9 SH. 4

TABLE N-2

ALLOCATION OF ANNUAL CHARGES
(in $1,000 at 1970 Price Level)
NOOKAGEE DAM AND LAKE, MASSACHUSETTS

	MULTIPLE-PURPOSE PROJECT				ALTERNATIVE SINGLE-PURPOSE PROJECTS	
	Specific Costs		JOINT USE			
	F.C.	W.Q.	COSTS	TOTAL	F.C.	W.Q.
ELEVATIONS (msl)						
Top of Dam				848	834	826
Spillway Crest				835	821	816
Top of F.C. Pool				835	821	--
Top of W.Q. Pool				816	--	816
PROJECT FIRST COSTS						
Lands & Damages			$ 915	$ 915	$ 795	$ 720
Relocations			1,100	1,100	950	880
Reservoir			160	160	40	150
Dam & Appurtenant Facilities		30	4,750	4,780	3,770	3,520
Bldgs., Grounds & Utilities			60	60	50	40
Perm. Oper. Equipt.			35	35	30	30
Engineering & Design			780	780	665	640
Supervision & Administration			570	570	470	450
TOTAL PROJECT FIRST COSTS		$ 30	$ 8,370	$ 8,400	$ 6,770	$ 6,430
INVESTMENT						
Construction Expenditure		30	8,370	8,400	6,770	6,430
Interest During Construction		2	428	430	350	330
Present Worth of Future Additions for Recreation			0	0	0	0
INVESTMENT		$ 32	$ 8,798	$ 8,830	$ 7,120	$ 6,760
ANNUAL CHARGES						
Interest		2	450	452	365	346
Amortization		0	3	3	2	2
Operation & Maintenance		5	41	46	24	22
Major Replacements		1	3	4	3	3
Net Loss to Fish & Wildlife		0	0	0	0	0
TOTAL ANNUAL CHARGES		$ 8	$ 497	$ 505	$ 394	$ 373

ALLOCATION OF ANNUAL CHARGES	F.C.	W.Q.	TOTAL
Benefits	$ 677	$ 373	$ 1,050
Alternative Project Cost	394	373	767
Benefits Limited by Alternative Cost	394	373	767
Separable Cost	132	111	243
Remaining Benefits	262	262	524
Allocated Joint Costs	131	131	262
ALLOCATION OF ANNUAL CHARGES	$ 263	$ 242	$ 505

EXHIBIT 9 SH. 5

TABLE N-3

ALLOCATION OF CONSTRUCTION COST
(in $1,000 at 1970 Price Level)
NOOKAGEE DAM AND LAKE, MASSACHUSETTS

	Flood Control	Water Quality	Total
ALLOCATION OF ANNUAL CHARGES (From Table N-2)	$ 263	$ 242	$ 505
ALLOCATION OF OPERATION & MAINTENANCE			
Separable Costs	24	22	46
Allocated Joint Costs	0	0	0
Total Allocation, O & M	24	22	46
ALLOCATION OF MAJOR REPLACEMENTS			
Separable Costs	1	1	2
Allocated Joint Costs	1	1	2
Total Allocation, Major Replacements	2	2	4
ALLOCATION OF INVESTMENT			
Annual Investment	237	218	455
Ratio of Annual Investment	52.1%	47.9%	100%
Allocated Investment	4,600	4,230	8,830
Present Worth of Future Additions for Recreation	0	0	0
Initial Investment	4,600	4,230	8,830
ALLOCATION OF CONSTRUCTION EXPENDITURES			
Specific Investment	0	32	32
Investment in Joint-Use Facilities	4,600	4,198	8,798
Construction Expenditure in Joint-Use Facilities	4,376	3,994	8,370
Percent of Construction Expenditure, Joint-Use Facilities	52.3%	47.7%	100%
Construction Expenditure in Specific Facilities	0	30	30
Total Construction Expenditures	4,376	4,024	8,400
SUMMARY			
Total Construction Expenditures	4,376	4,024	8,400
Annual Costs	263	242	505
Annual Benefits	677	373	1,050
Benefit/Cost Ratio	2.6	1.5	2.1

EXHIBIT 9 SH. 6

APPENDIX B

NASHUA RIVER BASIN CLASSIFICATION

WATER QUALITY STANDARDS
COMMONWEALTH OF MASSACHUSETTS

Commonwealth of Massachusetts
Water Resources Commission
Division of Water Pollution Control

NASHUA RIVER BASIN CLASSIFICATION

Boundary	Present Use	Anticipated Future Use	Present Condition	Classification
The North Branch of the Nashua River from the confluence of the Whitman River & Flag Brook in Fitchburg to the confluence of the South Branch of the Nashua River in Lancaster.	Industrial cooling & processing Assimilation	Recreational boating Fish & Wildlife propagation Fishing Industrial cooling & processing Assimilation	U & D	C
Flag Brook from its source to the Boston & Maine Railroad at Wachusetts Station in Fitchburg.	Fish & Wildlife propagation, Fishing Industrial cooling & processing Assimilation	Fish & Wildlife propagation Fishing Industrial cooling & processing Assimilation	U & D	B
Flag Brook from the Boston & Maine Railroad in Fitchburg to the confluence of the Whitman River in Fitchburg	Industrial cooling & Processing Assimilation	Fish & Wildlife propagation Fishing Industrial cooling & processing Assimilation	U	C
The Whitman River from its source to the confluence with Flag Brook in Fitchburg	Fish & Wildlife propagation Fishing Industrial cooling & processing Assimilation	Fish & Wildlife propagation Fishing Industrial cooling & processing Assimilation	U & C & B	B

NASHUA RIVER BASIN

Boundary	Present Use	Anticipated Future Use	Present Condition	Classification
Upper Naukeag Lake in Ashburnham and the tributaries thereto.	Water Supply	Same	A	A
Scott Brook and Scott Reservoir in Fitchburg.	Water Supply	Same	A	A
Fitchburg Reservoir in Ashby and the tributaries thereto.	Water Supply	Same	A	A
Lovell Reservoir on the Felulah Brook and the tributaries thereto.	Water Supply	Same	A	A
Meetinghouse Pond in Westminster and the tributaries thereto.	Water Supply	Same	A	A
Wachusett Lake in Westminster and Princeton and the tributaries thereto.	Water Supply	Same	A	A
Mare Meadow Reservoir and the tributaries thereto.	Water Supply	Same	A	A
Fall Brook Reservoir and Fall Brook in Leominster and the tributaries thereto.	Water Supply	Same	A	A

NASHUA RIVER BASIN

Boundary	Present Use	Anticipated Future Use	Present Condition	Classification
Notown Reservoir, Goodfellow and Sumond Ponds on the Monoosnoc Brook in Leominster and the tributaries thereto.	Water Supply	Same	A	A
Haynes, Morse, and distributing Reservoirs on a branch of the Monoosnoc Brook in Leominster	Water Supply	Same	A	A
Other streams in the Nashua River Watershed area unless denoted above.	-	-	-	B

COMMONWEALTH OF MASSACHUSETTS

WATER RESOURCES COMMISSION

DIVISION OF WATER POLLUTION CONTROL

WATER QUALITY STANDARDS

Adopted by the Massachusetts Division of Water Pollution Control on March 3, 1967, in accordance with the Provisions of Section 27 (4) of Chapter 21 of the General Laws, and in accordance with the procedure required by Chapter 30A of the General Laws, and after a public hearing held on February 17, 1967

Filed with Secretary
of State On
March 6, 1967

15M 3-67-944710 Estimated Cost Per Book .115

Standards of Water Quality

1. General - To achieve the objectives of the Massachusetts Clean Water Act and to assure best use of the waters of the Commonwealth, the following standards are adopted and shall be applicable to all waters of the Commonwealth or to different segments of the same waters. The Classes shall be assigned by the Division of Water Pollution Control.

In the classification of waters due consideration will be given to all factors involved including public health, public enjoyment, propagation and protection of fish and wildlife, and economic and social development. Classifications are not intended to permit indiscriminate waste disposal or to allow minimum efforts of waste treatment under any circumstance.

When an effluent is permitted to be discharged to the receiving waters, cognizance shall be given both in time and distance to allow for mixing of effluent and stream. Such distances required for complete mixing shall not affect the water usage Class adopted.

Recommendations on other waste parameters will constitute a portion of the continuing effort of the Division as improved standard methods are developed or revisions consistent with the enhancement of the waters of the Commonwealth are justified.

Water quality parameters not specifically denoted shall not exceed the recommended limits on the most sensitive and governing water class use. In areas where fisheries are the governing consideration and approved limits have not been established, bio-assays shall be performed as required by the appropriate agencies.

Standards of Water Quality

Fresh Waters

Class A - Waters designated for use as public water supplies in accordance with Chapter 111 of the General Laws. Character uniformly excellent.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 75% of saturation during at least 16 hours of any 24-hour period and not less than 5 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oil-grease-scum	None allowable
3. Color and turbidity	None other than of natural origin
4. Coliform bacteria per 100 ml.	Not to exceed an average value of 50 during any monthly sampling period.
5. Taste and odor	None other than of natural origin
6. pH	As naturally occurs
7. Allowable temperature increase	None other than of natural origin
8. Chemical constituents	None in concentrations or combinations which would be harmful or offensive to humans, or harmful to animal, or aquatic life.
9. Radioactivity	None other than that occurring from natural phenomena

Class B - Suitable for bathing and recreational purposes including water contact sports. Acceptable for public water supply with appropriate treatment. Suitable for agricultural, and certain industrial cooling and process uses; excellent fish and wildlife habitat; excellent aesthetic value.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 75% of saturation during at least 16 hours of any 24-hour period and not less than 5 mg/1 at any time.
2. Sludge deposits-solid refuse-floating solids-oils-grease-scum	None Allowable
3. Color and turbidity	None in such concentrations that would impair any usages specifically assigned to this class.
4. Coliform bacteria per 100 ml	Not to exceed an average value of 1000 during any monthly sampling period nor 2400 in more than 20% of samples examined during such period.
5. Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish.
6. pH	6.5 - 8.0
7. Allowable temperature increase	None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83° F in warm water fisheries, and 68° F in cold water fisheries, or in any case raise the normal temperature of the receiving water more than 4° F.

8. Chemical constituents	None in concentrations or combinations which would be harmful or offensive to human, or harmful to animal or aquatic life or any water use specifically assigned to this class.
9. Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.
10. Total phosphate	Not to exceed an average of 0.05 mg/l as P during any monthly sampling period.
11. Ammonia	Not to exceed an average of 0.5 mg/l as N during any monthly sampling period.
12. Phenols	Shall not exceed .001 mg/l at any time.

Class C - Suitable for recreational boating; habitat for wildlife and common food and game fishes indigenous to the region; certain industrial cooling and process uses; under some conditions acceptable for public water supply with appropriate treatment. Suitable for irrigation of crops used for consumption after cooking. Good aesthetic value.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 5 mg/l during at least 16 hours of any 24-hour period nor less than 3 mg/l at any time. For seasonal cold water fisheries at least 5 mg/l must be maintained.
2. Sludge deposits-solid-refuse floating solids-oils-grease-scum	None allowable except those amounts that may result from the discharge from waste treatment facilities providir appropriate treatment.

3. Color and turbidity	None allowable in such concentrations that would impair any usages specifically assigned to this class.
4. Coliform bacteria	None in such concentrations that would impair any usages specifically assigned to this class.
5. Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class, and none that would cause taste and odor to edible fish.
6. pH	6.0 - 8.5
7. Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive receiving water use and in no case exceed 83° F in warm water fisheries, and 68° F in cold water fisheries, or in any case raise the normal temperature of the receiving water more than 4° F.
8. Chemical constituents	None in concentrations or combinations which would be harmful or offensive to human, or harmful to animal or aquatic life or any water use specifically assigned to this class.
9. Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.
10. Total phosphate	Not to exceed an average of 0.05 mg/l as P during any monthly sampling period.

11. **Ammonia**	**Not to exceed an average of 1.0 mg/l as N during any monthly sampling period.**
12. **Phenols**	**Not to exceed an average of 0.002 mg/l at any time.**

Class D - Suitable for aesthetic enjoyment, power, navigation, and certain industrial cooling and process uses. Class D waters will be assigned only where a higher water use class cannot be attained after all appropriate waste treatment methods are utilized.

Item	Specifications
1. Dissolved oxygen	Not less than 2 mg/l at any time.
2. Sludge deposits - solid refuse-floating solids-oils-grease-scum	None allowable except those amounts that may result from the discharge from waste treatment facilities providing appropriate treatment.
3. Color and turbidity	None in such concentrations that would impair any usages specifically assigned to this class.
4. Coliform bacteria	None in such concentrations that would impair any usages specifically assigned to this class.
5. Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class.
6. pH	6.0 - 9.0
7. Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive receiving water use and in no case exceed 90° F.
8. Chemical constituents	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the designated water use.

9. Radioactivity	None in such concentrations or combinations which would be harmful to human, animal, or aquatic life for the designated water use. None in such concentrations which will result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.

Notes:

1. All wastes shall receive appropriate waste treatment which is defined as secondary treatment with disinfection or its industrial waste treatment equivalent except when a higher degree of treatment is required to meet the objectives of the water quality standards, all as determined by the Division of Water Pollution Control. Disinfection from October 1 to May 1 may be discontinued at the discretion of the Division of Water Pollution Control.

2. Appropriate water supply treatment is as determined by the Massachusetts Department of Public Health.

3. These water quality standards do not apply to conditions brought about by natural causes.

4. Class B, & C waters shall be substantially free of pollutants that will:

   (1) unduly affect the composition of bottom fauna

   (2) unduly affect the physical or chemical nature of the bottom

   (3) interfere with the spawning of fish or their eggs

5. The average minimum consecutive 7 day flow to be expected once in ten years shall be used in the interpretation of the standards except where noted.

6. The amount of disinfection required shall be equivalent to a free and combined chlorine residual of at least 1.0 mg/l after 15 minutes contact time during peak hourly flow or maximum rate of pumpage.

APPENDIX C

LETTERS OF COMMENT AND CONCURRENCE

APPENDIX C

LETTERS OF COMMENT AND CONCURRENCE

WHITMANVILLE LAKE

NORTH NASHUA RIVER BASIN, MASSACHUSETTS

CONTENTS

FEDERAL POWER COMMISSION
REGIONAL OFFICE
346 BROADWAY
NEW YORK 13, NEW YORK 10013

January 30, 1964

Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts

Subject: Proposed Reservoir Projects,
North Nashua River Basin

Dear Sir:

Reference is made to your letter of October 18, 1963, requesting our comments on the hydroelectric power potentialities of six proposed reservoir projects located on the North Nashua and Baker Brook tributaries of the Merrimack River.

A review of the pertinent project data furnished with your letter indicates that only a relatively small amount of hydro power could be developed at any of the proposed projects (less than 100 kw). This is due largely to the limited run-off provided by the small tributary drainage areas involved, which range from 1.7 to 17.5 square miles.

It is concluded, therefore, that none of the six proposed reservoir projects are adapted to the practicable and economic development of hydroelectric power in conjunction with other project purposes.

Sincerely yours,

D. J. Wait
Regional Engineer

EXHIBIT C-1

UNITED STATES GOVERNMENT
ENVIRONMENTAL PROTECTION AGENCY
REGION I
NEW ENGLAND BASINS OFFICE
240 HIGHLAND AVENUE
NEEDHAM HEIGHTS, MASSACHUSETTS 02194

August 3, 1971

Mr. John Wm. Leslie
Chief, Engineering Division
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

I have your letter of July 2, 1971 describing changes in the design of the proposed Whitmanville and Nookagee reservoir projects in the North Nashua River Basin, Massachusetts. The changes involve the deletion of water supply storage from both sites, the inclusion of 3,800 acre feet of storage for low flow augmentation for water quality (3,000 acre feet of which would be at the Nookagee site), and the transfer of the main recreational development from the Nookagee site to the Whitmanville site.

The proposal, as outlined, is consistent with the recommendations contained in our report, "Water Quality Control Study, North Nashua River Basin," dated April, 1968, and our letter of October 31, 1969.

It should be noted that the river flow values contained in the above letter are total river flows. Maintenance of this regime will require coordinated releases from existing reservoirs owned and operated by local interests as well as from the Nookagee and Whitmanville projects. Firm assurance that the existing reservoirs will be operated in an appropriate fashion is essential if the water quality benefits from the Federal reservoir projects are to be realized.

FOR THE REGIONAL ADMINISTRATOR:

Sincerely yours,

Bart Hague

Bart Hague
Chief of Planning

EXHIBIT C-2

COMMENTS OF THE COMMONWEALTH OF MASSACHUSETTS

The Commonwealth of Massachusetts

Water Resources Commission

15 SCHOOL STREET. BOSTON 02108

OFFICE OF THE DIRECTOR

December 2, 1965

William F. Cassidy
Lieutenant General, USA
Chief of Engineers
Department of the Army
Washington, D.C. 20315

RE: North Nashua River Project in Massachusetts.

ENGCW-PD

Dear Sir:

The Commonwealth of Massachusetts is vitally interested in the multi-purpose development proposed by the New England Division, Corps of Engineers, on the North Nashua River in the vicinity of Fitchburg and Leominster, Massachusetts.

The Commission points out that the area is badly in need of flood control, additional industrial water supply, and recreational water. This area has been critically short of water during the current drought and it is evident that, even with increased public water supplies which may be provided in the next few years, all possible sources of water for industry and recreation should be developed as soon as possible.

This Commission will support any State legislation necessary to carry out the local requirement of the project.

It is urged that the North Nashua River Project be authorized at the earliest possible date.

Very truly yours,

Malcolm E. Graf

Malcolm E. Graf
Director and Chief Engineer

MEG/n

EXHIBIT C-3

The Commonwealth of Massachusetts
Water Resources Commission
State Office Building, Government Center
100 Cambridge Street, Boston 02202

OFFICE OF THE DIRECTOR
DIVISION OF WATER
POLLUTION CONTROL

July 10, 1969

Colonel Frank P. Bane, Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: Flow Augmentation,
Nashua River Basin

Dear Colonel Bane:

On July 7, 1969, a member of my staff attended a meeting arranged by your office and held in the office of the Mayor of Fitchburg. The purpose of the meeting, attended by representatives of Federal, State, and local interests, was the water resource development plan of the Corps of Engineers for the Nashua River Basin. It was pointed out that funds had been appropriated for the design of two of the authorized projects - Whitmanville and Nookagee- and that firm decisions had to be made by local interests relative to inclusion of storage for municipal and/or industrial water supply.

The Northeast Regional Office of the Federal Water Pollution Control Administration has made a water quality control study of the North Nashua River Basin. Their report finds that, to meet the assigned water quality classification, flow augmentation would be required during July and August, with a minor amount in September, to maintain a dissolved oxygen content of 5 mg/l. The report further finds that storage for water quality purposes could best be developed in the Whitmanville, Nookagee and/or Phillips projects. This Division concurs, in general, in these findings.

At the above-referenced meeting, representatives of the paper companies indicated that one of the reasons for their apparent disinterest in storage for industrial water supply was the cost allocated thereto. It is suggested that consideration be given to the feasibility of joint use of certain storage for industrial water supply and water quality control. It is possible that such joint use might make participation more attractive to the paper companies. By use of available computer programs, it should be possible to indicate to the paper companies the cost for several different amounts of storage and augmentation.

EXHIBIT C-4

Whether the decision is made to include storage for industrial water supply or not, this Division strongly recommends that consideration be given to including storage in either or both projects for water quality control purposes, substantially in accordance with the findings and report of the Federal Water Pollution Control Administration.

Representatives of this Division will be happy to meet with members of your staff to discuss this in further detail.

Very truly yours,

Thomas C. McMahon
Director

TCM/WAS/mpf

cc: FWPCA, New England Basins Office
Mass. Division of Water Resources

The Commonwealth of Massachusetts
Department of Natural Resources
Leverett Saltonstall Building, Government Center
100 Cambridge Street, Boston 02202

February 1, 1971

Colonel Frank P. Bane
Corps of Engineers
Division Engineer
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Bane:

Representatives of the Department of Natural Resources have made a preliminary examination of the area associated with the proposed flood control dam on the Whitman River in Westminster and Ashburnham.

We are interested in working out the components of a mutually agreeable recreational lease on this area.

Our interest is predicated on the maintenance of the present dam and water levels as are existant in the Weyerhauser Company holdings. This presents an attractive and usable recreational shoreline. We understand that retention of this structure is being considered.

We would also like to work out an agreement with the Massachusetts Department of Mental Health relative to the disposition of it's property, connected with the Gardner State Hospital. This property is on the west side of the project. There are other matters of mutual interest with this Department that could be included in discussions of this matter.

I welcome the opportunity to jointly plan and implement the recreational activities at this project location.

Very truly yours,

Arthur W. Brownell
Commissioner

AWB/GAB/dd

EXHIBIT C-5

FRANCIS W. SARGENT
GOVERNOR

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT
STATE HOUSE, BOSTON 02133

July 23, 1971

Colonel Frank P. Bane
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Bane:

Thank you for your status report on the North Nashua project. I enthusiastically support your efforts to obtain a significant water based recreation area at Whitmanville which will help serve the Gardner-Fitchburg-Leominster area.

I was pleased to read in the Environmental Guidelines for the Civil Works Program of the Corps of Engineers that under "planning (f)," if a measure has "a detrimental net effect on the environment, the Corps will seek means for modifying it to ameliorate its environmental effects." This policy assumes importance at the Nookagee Site, because "drawdowns over five feet are considered excessive and detrimental to recreation by exposing large, unsightly areas along the shoreline," and I have been informed that the estimated average annual drawdown here will be fourteen feet.

Though this project will be used primarily for flow augmentation, steps should be taken to prevent esthetic deterioration of the site. Your environmental statement acknowledged this potential problem, and discussed the possibility of exploring measures to alleviate "odor and visual problems." I recommend that great attention be given to this in the final design, construction and operation of the Nookagee Reservoir. Acquisition and enhancement of buffer areas and alteration of the pool bottom should also be considered.

EXHIBIT C-6

Our Department of Natural Resources informs me that there is a need for flow augmentation to help meet water quality standards in the North Branch of the Nashua River. They recommend that, in order that flows released for this purpose do not merely become a new source of process water for industrial use, the Corps of Engineers should insure that the federally augmented flows pass down the Nashua free from withdrawal uses in the critical areas. This might be accomplished by a guarantee of the maintenance of specific minimum instantaneous flows in the natural river channel.

I assure you that my office and the Department of Natural Resources will cooperate in your efforts to enhance and preserve the environmental quality of these areas.

With best wishes,

Sincerely,

Francis W. Sargent

NEW ENGLAND RIVER BASINS COMMISSION
55 COURT STREET · BOSTON, MASSACHUSETTS 02108
PHONE: (617) 223-6244

July 26, 1971

Mr. John Wm. Leslie, Chief
Engineering Section
Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Mr. Leslie:

Reference is made to your letter of July 2, 1971, requesting comments on a revised plan for the proposed Witmanville and Nookagee resevoirs on the North Nashua River Multi purpose project.

I am pleased to say that after examing the site plans and your letter, you have come forth with a sensible solution to the problem created when the city of Fitchburg and the Industry declined to participate in the water supply features of the original plan.

In so far as EPA through its predecessor FWQA has requested low flow augmentation for water quality control, I would expect that this portion of the project would be paid through Federal Funding. If not, then we would have to explore the possibility of state participation. In any event should low flow augmentation be dropped from the project for any reason, such as high quality treatment plant discharges, it would be most desireable to provide the flows for the main stream where releases of only 12 million gallon per week are required, equal to 1.1 c.f.s., by the enabling legislation for the Wachusett Resevoir which has a tributary area of about 118 square miles.

I sincerely hope that your new real estate acquition requirements do not put this worth while project out of reach on the benefit cost ration side of the picture.

Thank you for this opportunity to comment on this project.

Sincerely yours,

Malcolm Graf

MG:bor

Malcolm Graf

EXHIBIT C-7

Weyerhaeuser Company

Box 601 • Fitchburg, Mass. 01420
Area Code 617-343-3051

August 2, 1971

Mr. John Wm. Leslie
Chief, Engineering Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

This is a more detailed reply to your letter July 2, 1971, on the proposed Whitmanville and Nookegee flood control projects.

We want to reiterate our concern over water quality and release control of the Whitmanville system. Water quality from this watershed has deteriorated in the last few months in that resistivity has decreased from about 12,000 ohms to 9,000 ohms in Snow Mill Pond. This decrease forced us to change production schedules and, unless resistivity improves, we may be forced to give up a product line important to our survival as a paper manufacturer in Fitchburg.

We are particularly concerned about the possibility (probability) of further deterioration in resistivity and the possibility of siltation reducing the storage capacity of our two reservoirs below Whitmanville during the construction phase of the Whitmanville dam. We think that our current problems with water quality in Snow Mill Pond are related to the construction of the Montachusett Regional Technical Vocational school. It is vital that we do not experience further degradation of water quality from this watershed.

As you know, no paper can be manufactured without water of suitable quality and in sufficient quantity. Therefore, we are also concerned about who will determine and make decisions regarding how much water will be released in any given time period. In other words, the Weyerhaeuser Company and the Nashua River Reservoir Company must be able to obtain stored water as the need arises.

EXHIBIT C-8

Your letter states that industry "withdrew" its support of the water supply feature of the proposed facilities. Industry's position and Weyerhaeuser's position from the beginning was that while anyone would like to have more water, we may not be able to afford it. I think the insurance analogy was used to describe our position; that is, one would like to have a million dollars worth of insurance protection but maybe he can afford only $10,000 worth. Our position remains unchanged. In discussions with the Corps of Engineers during the three and a half years I have been in Fitchburg, we said we could not justify expenditures for additional water supply and that we had survived a severe drought during which we improved our ability to conserve water.

We still feel that our present storage is sufficient for our needs and that if we do not lose any storage capacity and if the quality of the water does not deteriorate, we will not be hurt by the Whitmanville flood control project.

Weyerhaeuser whole heartedly supports the principle of flood control and the principle of low flow augmentation enhancing the stream quality as important benefits to the citizens of this community.

Thank you for your very informative letter and the sketches and drawings which you sent us. After you have had a chance to read and discuss our thoughts, perhaps we should get together again.

Sincerely yours,

Edward A. Newcomb
Branch Manager

EAN:pb

APPENDIX D

PROJECT COST AND COST ALLOCATION

APPENDIX D

PROJECT COST AND COST ALLOCATION

WHITMANVILLE LAKE

NORTH NASHUA RIVER BASIN, MASSACHUSETTS

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APPENDIX D

PROJECT COST AND COST ALLOCATION

WHITMANVILLE LAKE

NORTH NASHUA RIVER BASIN, MASSACHUSETTS

1. General. - The Whitmanville Lake Project has a drainage area of 17.5 square miles and is located on the Whitman River in the town of Westminster, Massachusetts. The reservoir is designed for multiple-use by three purposes, namely; flood control, water quality control and recreation. Allocation of costs is required in order that all authorized purposes served by the project share equitably in the joint savings of multiple-purpose construction.

2. Method of Allocation of Costs. - Allocation of costs of the multiple-purpose project to the purposes of flood control, water quality and recreation were made by the separable costs - remaining benefits method. Costs allocated to recreation were apportioned to Federal and non-Federal interests in accordance with the cost sharing policy established by the Federal Water Project Recreation Act (Public Law 89-72) 89th Congress, approved July 9, 1965.

3. Project Description. - The project is fully described in the text of this General Design Memorandum. The total reservoir storage capacity of 7,850 acre-feet consists of:

1,150 acre-feet to maximum Elev. 817.5 for water supply replacement

1,400 acre-feet to maximum Elev. 826.6 for joint use*

*Joint Use:

Recreation - Apr. thru Labor Day

Water Quality - Sept. and Oct. (800 a.f.)

6,700 acre-feet to maximum Elev. 845.0 for flood control**

**Flood Control:

6,700 a.f. available Nov. thru Mar.

5,300 a.f. available Apr. thru Aug.

5,300 - 6,700 a.f. available Sept. and Oct.

Specific facilities include a monitoring system for water quality control, and recreational facilities (including 13 acres of land) provided for boating, fishing and picnicking. All other project features are joint use.

4. Operational Requirements. - The flood and water quality storage controls will be operated by the Corps of Engineers. Control of the water supply storage will be by the Corps but as directed by the Nashua River Reservoir Company. Recreational facilities will be operated by the Department of Natural Resources of the Commonwealth of Massachusetts.

5. Project Costs, Annual Charges and Benefits.

a. Construction Costs. - The total cost of the project including lands and damages is estimated at $7,750,000 at 1971 price levels. A detailed breakdown is shown in Table D-5. The feature of lands and damages includes the additional costs for resettlement and acquisition as required under the recently enacted "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970", P. L. 91-646.

b. Interest During Construction. - Accrued interest during construction is computed on the basis of a three-year construction period. This was derived by multiplying the total construction expenditures by the 5.375 percent interest rate and by one-half of the construction period in years.

c. Annual Charges. - A breakdown of annual charges is shown in Table D-6.

(1) Interest and Amortization. - The project is considered to have an economic life of 100 years. Interest is computed at 5.375 percent amortized over a 100-year period.

(2) Operation and Maintenance. - This item is estimated on the basis of experience with other similar projects in the New England Area. Included are costs for maintenance of the project structures and for operation of multiple-purpose project features and recreational facilities. It also includes operational procedures of the gates for flood control and water quality control, as well as the permanent operating equipment and gages for monitoring and recording the water quality and fluctuating storage in the reservoir. Further, the preparation of necessary reports to the Reservoir Control Center at NED Headquarters for regulating instructions are also included.

(3) Major Replacements. - Allowance is made for replacement of items deemed to have a usable life less than that of the project which is 100 years.

d. Project Benefits. - The dual-purpose and single-purpose projects represent the most economical alternatives in which the benefit for each of the purposes is the same as the benefit of the respective purpose in the recommended project. All the alternatives except the single purpose water quality alternate are considered at the same site as the recommended three-purpose project. The Nookagee Lake site was utilized as the most reasonable single-purpose water quality alternate. The storage capacities and elevations of each of the alternatives and the recommended project are shown in Table D-1.

(1) Flood Control Benefits. - Average annual flood control benefits adjusted for the growth projected to take place in the basin are estimated at $1,338,000. This value is based on Whitmanville Lake acting in a system with Nookagee Lake and Phillips Dam after completion of the downstream channel improvement along the North Nashua River.

(2) Recreation Benefits. - Recreation benefits are based on annual visitation of 100,000 @ $1.25 per day. Total annual recreational benefits are estimated at $125,000.

(3) Water Quality Control Benefits. - Water quality control benefits are estimated on the basis of a single purpose water quality control dam and reservoir at the Nookagee project site. This represents the most economical alternate in the absence of the project. A benefit-cost ratio of unity is assumed for this alternative project. Total benefits for the North Nashua River Basin water quality control are estimated at $552,000 of which 21% ($116,000) was accredited to Whitmanville.

TABLE D-1

CAPACITIES AND ELEVATIONS

Purpose	Storage in Acre Feet	Storage in Inches of Runoff	STORAGE CAPACITIES IN ACRE FEET						
			Recommended Project	TWO PURPOSE PROJECTS			SINGLE PURPOSE PROJECTS		
			FC, REC & WQC	REC & WQC	FC & WQC	FC & REC	FC	REC	WQC
Flood Control	6,700	7.2	6,700	-	6,700	6,700	6,700	-	-
Water Supply (1)	1,150	1.2	1,150	1,150	1,150	1,150	1,150	1,150	-
Water Quality	(800)	(0.85)	(800)(3)	(800)(3)	(800)(2)	-	-	-	800
Recreation	(1,400)	(1.5)	(1,400)(2)	1,400	-	(1,400)(2)	-	1,400	-
Total	7,850	8.4	7,850	2,550	7,850	7,850	7,850	2,550	800
Full Pool Elev., Ft. - MSL			845	826.6	845	845	845	826.6	820.5(4)

(1) Replacement of existing water supply.

(2) Seasonal encroachment on flood control storage.

(3) Included as part of 1,400 a.f. for recreation.

(4) Nookagee site.

6. Cost Allocations. - Costs to the project purposes were allocated by the Separable-Costs Remaining Benefits method. Table D-7 outlines in detail the cost allocations and Table D-2 summarizes the results of allocation for the recommended project. The total investment includes the first cost plus interest during construction.

TABLE D-2

SUMMARY OF COST ALLOCATIONS

Purpose	First Cost	Total Investment	Annual Charges
Flood Control	$5,370,000	$5,800,000	$349,000
Recreation	1,230,000	1,328,000	93,000
Water Quality Control	1,150,000	1,247,000	78,000
Totals	$7,750,000	$8,375,000	$520,000

7. Comparison of Benefits and Costs. - A comparison of benefits accruing to each project purpose with the costs allocated to the respective purpose indicates that each project purpose is amply justified as shown in Table D-3.

TABLE D-3

ECONOMIC ANALYSIS

Purpose	Annual Benefits	Annual Costs	Benefit-Cost Ratio
Flood Control	$1,338,000	$ 349,000	3.83
Recreation	125,000	93,000	1.34
Water Quality Control	116,000	78,000	1.49
Totals	$1,579,000	$ 520,000	3.04

8. Apportionment of Costs Among Interests.

a. Federal. - Flood control and water quality control benefits realized from construction of the recommended project are widespread and payable in full by the Federal Government. The separable first cost of recreation, namely, the difference in first cost between the recommended project and the 2-purpose project with recreation omitted, is divided equally between the Federal and non-Federal interests under the provisions of the Federal Water Project Recreation Act of 1965. The Federal share is presently estimated at $175,000.

b. Non-Federal. - With respect to recreation facilities, local interests will be required to cooperate to the following extent:

In accordance with the Federal Water Project Recreation Act of 1965 agree to:

Administer project land and water areas for recreation and fish and wildlife;

Pay, contribute in kind, or repay (which may be through user fees) with interest, one-half of the separable first cost of the project allocated to recreation and fish and wildlife, an amount currently estimated at $175,000 based on the presently planned level of development for these purposes;

Bear all costs of operation, maintenance and replacement of facilities for recreation and fish and wildlife, an amount currently estimated at $18,000 annually.

c. Summary of Apportionment of Costs Among Interests. - A summary of the apportionment of costs among interests is shown in the following table:

TABLE D-4

COST APPORTIONMENT AMONG INTERESTS

Purpose	Federal	Non-Federal	Total
First Costs:			
Flood Control	$5,370,000		$5,370,000
Recreation	1,055,000	$175,000	1,230,000
Water Quality Control	1,150,000		1,150,000
Totals	$7,575,000	$175,000	$7,750,000

9. Cost Estimates. - A summary of major construction items together with estimated first costs is given in Table D-6. Also included are estimates of investments, and average annual charges for the recommended three-purpose project, specific and joint-use costs, and separate single-purpose and two-purpose projects computed for cost allocation purposes. The detailed cost allocation is shown in Table D-7.

TABLE D-5

DETAILED COST ESTIMATE
(1971 Price Level)

	Description	Quantity	Unit	Unit Price	Estimated Amount
01.	Lands and Damages				
	Lands, Acquisition & Resettlement				$ 1,400,000
02.	Relocations				
	Roads	1	Job	L.S.	970,000
	Telephone	1	Job	L.S.	24,000
	Electric	1	Job	L.S.	11,000
	Water Line	1	Job	L.S.	5,000
	Sub-Total				1,010,000
	Contingencies				120,000
	TOTAL RELOCATIONS				$1,130,000
03.	Reservoir				
	Log Boom	1	Job	L.S.	$ 5,000
	Reservoir Clearing	70	Ac.	$900	63,000
	Grubbing & Stripping	113,000	C.Y.	.90	102,000
	Contingencies				30,000
	TOTAL RESERVOIR				$ 200,000
04.	Dam				
	Preparation of Site	1	Job	L.S.	$ 15,000
	River Diversion	1	Job	L.S.	10,000
	Control of Waters	1	Job	L.S.	250,000
	Unclassified Excavation - General	260,000	C.Y.	$1.00	260,000
	Unclassified Excavation - Impervious Borrow	460,000	C.Y.	1.40	644,000
	Rock Excavation - Open Cut	49,000	C.Y.	4.10	200,900
	Hand Cleaned Bedrock Surface	370	Sq.	35.00	12,900

TABLE D-5 (Continued)

Description	Quantity	Unit	Unit Price	Estimated Amount
04. Dam				
Compacted Impervious Fill	400,000	C.Y.	$ .40	$ 160,000
Compacted Random Fill, Class I	120,000	C.Y.	.40	48,000
Compacted Random Fill, Class II	23,000	C.Y.	.40	9,200
Compacted Pervious Fill	40,000	C.Y.	.40	16,000
Compacted Gravel Fill	300	C.Y.	3.00	900
Compacted Sand Fill	43,000	C.Y.	3.50	150,500
Compacted Processed Sand Fill	15,800	C.Y.	5.25	83,000
Compacted Impervious Backfill	700	C.Y.	7.00	4,900
Compacted Gravel Backfill	2,300	C.Y.	6.50	15,000
Gravel Bedding	37,100	C.Y.	2.00	74,200
Road Gravel	650	C.Y.	3.20	2,000
Additional Embankment Rolling	100	Hrs.	30.00	3,000
Rock Protection	43,600	C.Y.	3.10	135,000
Foundation Grouting	1	Job	L.S.	150,000
Concrete - Inlet & Outlet Structures	310	C.Y.	90.00	27,900
Concrete - Intake Tower to El. 860.0	1,340	C.Y.	80.00	107,200
Concrete - Intake Tower above El. 860.0	70	C.Y.	175.00	12,250
Concrete - Transition & Conduit	770	C.Y.	90.00	69,300
Concrete - Spillway Retaining Walls & Weir	1,500	C.Y.	75.00	112,500
Concrete - Service Bridge Abutment	220	C.Y.	75.00	16,500
Concrete - Service Bridge Deck	60	C.Y.	110.00	6,600
Concrete - Found. Prep.	50	C.Y.	60.00	3,000
Cement	6,400	Bbl.	6.00	38,400
Steel Reinforcement	200,000	Lbs.	.25	50,000
Rubber Water Stop	450	L.F.	5.00	2,250
Anchors	50	Ea.	50.00	2,500
Structural Steel - Misc.	7,000	Lbs.	.60	4,200
Structural Steel Service Bridge	1	Job	L.S.	50,000
Aluminum	5,500	Lbs.	3.00	16,500
Misc. Metals	6,000	Lbs.	2.00	12,000
Intake Tower - Superstructure	1	Job	L.S.	4,000
Gate Vent System	1	Job	L.S.	8,000
Float Well & Accessories	1	Job	L.S.	5,000
Heating & Ventilating System	1	Job	L.S.	4,000

TABLE D-5 (Continued)

	Description	Quantity	Unit	Unit Price	Estimated Amount
04.	Dam				
	Hydraulic Gates & Machinery	1	Job	L.S.	$ 65,000
	Emergency Stop Gate	1	Job	L.S.	10,000
	Water Supply System Pipes and Gates	1	Job	L.S.	25,000
	Crane and Hoist	1	Job	L.S.	5,000
	Diesel Engine	1	Job	L.S.	6,000
	Sump Pump	1	Job	L.S.	2,000
	Electric Work	1	Job	L.S.	20,000
	Tile Gage	1	Job	L.S.	1,500
	4' Chain Link Fence	800	L.F.	4.00	3,200
	18' Double Swing Gate	1	Ea.	400.00	400
	Topsoiling	2,500	C.Y.	7.00	17,500
	Seeding	6	Ac.	800.00	4,800
	Sub-Total				$2,957,000
	Contingencies				443,000
	TOTAL DAM				$3,400,000
08.	Roads				
	Roads	1	Job	L.S.	$ 30,000
	Contingencies				5,000
	TOTAL ROADS				$ 35,000
14.	Recreation Facilities				
	Recreation	1	Job	L.S.	$ 228,000
	Contingencies				32,000
	TOTAL RECREATION FACILITIES				$ 260,000
19.	Building, Grounds and Utilities				
	Bldg., Grounds & Util.	1	Job	L.S.	$ 95,000
	Contingencies				15,000
	TOTAL BUILDING, GROUNDS & UTILITIES				$ 110,000

TABLE D-5 (Continued)

	Description	Quantity	Unit	Unit Price	Estimated Amount
20.	Permanent Operating Equipment				
	Perm. Oper. Equipment	1	Job	L.S.	$ 52,000
	Contingencies				8,000
	TOTAL PERMANENT OPERATING EQUIPMENT				$ 60,000
30.	Engineering & Design				$ 685,000
31.	Supervision & Administration				$ 470,000
	TOTAL PROJECT FIRST COST				$7,750,000

TABLE D-6

SUMMARY OF CONSTRUCTION EXPENDITURES AND ANNUAL CHARGES

(In $1,000 - 1971 Price Level)

Project Features	RECOMMENDED MULTIPLE-PURPOSE PROJECT					ALTERNATIVE TWO-PURPOSE PROJECTS			ALTERNATIVE SINGLE-PURPOSE PROJECTS		
	Specific Costs										
	Flood Control	Recreation	Water Quality Control	Joint-Use Costs	Total Costs	Recreation Water Quality	Flood Control Water Quality	Flood Control Regregation	Flood Control	Recreation	Water Quality Control
Lands & Damages				$ 1,400	$ 1,400	$ 480	$ 1,480	$ 1,480	$ 1,400	$ 480	21% of total
Relocations				1,130	1,130	340	1,130	1,130	1,130	340	
Reservoir				200	200	200	160	280	60	280	cost of Single-
Dam				3,400	3,400	2,730	3,400	3,350	3,340	2,785	
Roads				35	35	25	35	35	35	25	Purpose Hookages
Recreation Facilities		260			260	260	- -	260	-	260	
Bldgs., Grounds & Utils.				110	110	60	130	100	60	40	Project
Permanent Operating Equip.			20	40	60	40	50	40	40	30	
Engineering & Design		35	3	647	685	545	655	670	600	540	(0.21 x $8,400)
Supervision & Administration		25	2	443	470	370	480	485	435	360	
TOTAL PROJECT FIRST COST	0	$320	$ 25	$7,405	$ 7,750	$5,050	$ 7,480	$7,650	$ 7,100	$5,000	$ 1,800
Construction Period (Years)					3	2	3	3	3	2	3
Spillway Crest Elev., Ft.-MSL					845	826.6	845	845	845	826.6	820.5 (1)
Investment & Annual Charges											
Construction Expenditures		320	25	7,405	7,750	5,050	7,400	7,650	7,100	5,000	1,800
Interest During Construction		26	2	597	625	271	597	617	572	269	145
Total Investment		346	27	8,002	8,375	5,321	7,997	8,267	7,672	5,269	1,945
Annual Charges:											
Int. & Amort.		19	1	432	452	288	432	447	414	285	105
Oper. & Maint.		16	5	41	62	38	46	57	24	30	10
Major Replacements		2		4	6	4	4	5	3	3	1
TOTAL ANNUAL CHARGES	0	37	6	477	520	330	482	509	441	318	116

(1) Hookages Site

[redacted]

WHITMANVILLE LAKE - COST ALLOCATION
ALLOCATION BY SEPARABLE COSTS-REMAINING BENEFITS METHOD

ITEM	FLOOD CONTROL	WATER SUPPLY	RECREATION	WATER QUALITY CONTROL	NAVIGATION	POWER	TOTAL
A. ALLOCATION OF ANNUAL COSTS-							
1. BENEFITS	1338000.	0.	125000.	116000.	0.	0.	1579000.
2. ALTERNATE COSTS	441000.	0.	318000.	116000.	0.	0.	875000.
3. BENEFITS LIMITED BY ALTERNATE COST	441000.	0.	125000.	116000.	0.	0.	682000.
4. SEPARABLE COST	190000.	0.	38000.	11000.	0.	0.	239000.
5. REMAINING BENEFITS	251000.	0.	87000.	105000.	0.	0.	443000.
6. RATIO OF REMAINING BENEFITS *	56.659	0.000	19.639	23.702	0.000	0.000	100.000
7. ALLOCATED JOINT COSTS	159212.	0.	55185.	66803.	0.	0.	281000.
8. TOTAL ALLOCATION, PROJECT COST	349212.	0.	93185.	77603.	0.	0.	520000.
B. ALLOCATION OF LOSS OF PRODUCTIVITY							
1. SEPARABLE COSTS	0.	0.	0.	0.	0.	0.	0.
2. ALLOCATED JOINT COSTS	0.	0.	0.	0.	0.	0.	0.
3. TOTAL ALLOCATIONS	0.	0.	0.	0.	0.	0.	0.
C. ALLOCATION OF OPERATION + MAINTENANCE							
1. SEPARABLE COSTS	24000.	0.	16000.	5000.	0.	0.	45000.
2. ALLOCATED JOINT COSTS	9632.	0.	3339.	4029.	0.	0.	17000.
3. TOTAL ALLOCATION	33632.	0.	19339.	9029.	0.	0.	62000.
4. SPECIFIC COSTS	0.	0.	16000.	5000.	0.	0.	21000.
5. ALLOCATED JOINT-USE COSTS	33632.	0.	3339.	4029.	0.	0.	41000.
6. RATIO FOR ALLOC OF JOINT-USE COSTS	82.029	0.000	8.143	9.828	0.000	0.000	100.000
D. ALLOCATION OF MAJOR REPLACEMENTS							
1. SEPARABLE COSTS	2000.	0.	2000.	1000.	0.	0.	5000.
2. ALLOCATED JOINT COSTS	567.	0.	196.	237.	0.	0.	1000.
3. TOTAL ALLOCATIONS	2567.	0.	2196.	1237.	0.	0.	6000.
4. SPECIFIC COSTS	0.	0.	2000.	0.	0.	0.	2000.
5. ALLOCATED JOINT-USE COSTS	2567.	0.	196.	1237.	0.	0.	4000.
E. ALLOCATION OF INVESTMENT + FIRST COST							
1. ANNUAL INVESTMENT	313014.	0.	71650.	67336.	0.	0.	452000.
2. ALLOCATED INVESTMENT	5799753.	0.	1327588.	1247659.	0.	0.	8375000.
3. RATIO OF ALLOCATED ANNUAL INVEST. *	69.251	0.000	15.852	14.897	0.000	0.000	100.000
4. INITIAL CONSTRUCTION EXPENDITURE	5366936.	0.	1228514.	1154550.	0.	0.	7750000.
F. ALLOCATION OF CONSTRUCTION EXPENDITURE							
1. SPECIFIC INVESTMENT	0.	0.	346000.	27000.	0.	0.	373000.
2. INVESTMENT IN JOINT-USE FACILITIES	5799753.	0.	981588.	1220659.	0.	0.	8002000.
3. INTEREST DURING CONST,JOINT-USE FAC.	432698.	0.	73233.	91069.	0.	0.	597000.
4. CONST.EXPENDITURE IN JOINT-USE FAC.	5367055.	0.	908355.	1129590.	0.	0.	7405000.
5. RATIO OF CONST.EXP.IN JOINT-USE FAC.	72.479	0.000	12.267	15.254	0.000	0.000	100.000
6. CONST.EXPENDITURE IN SPECIFIC COSTS	0.	0.	320000.	25000.	0.	0.	345000.
7. TOTAL CONSTRUCTION EXPENDITURES	5367055.	0.	1228355.	1154590.	0.	0.	7750000.
G. SUMMARY							
1. TOTAL CONST.EXPENDITURES (ROUNDED)	5370000.	0.	1230000.	1150000.	0.	0.	7750000.
2. ANNUAL COSTS	349212.	0.	93185.	77603.	0.	0.	520000.
3. ANNUAL BENEFITS -	1338000.	0.	125000.	116000.	0.	0.	1579000.
4. BENEFIT/COST RATIO *	3.83	0.00	1.34	1.49	0.00	0.00	3.04